AMERICAN ENGINEER AND RAILROAD JOURNAL.

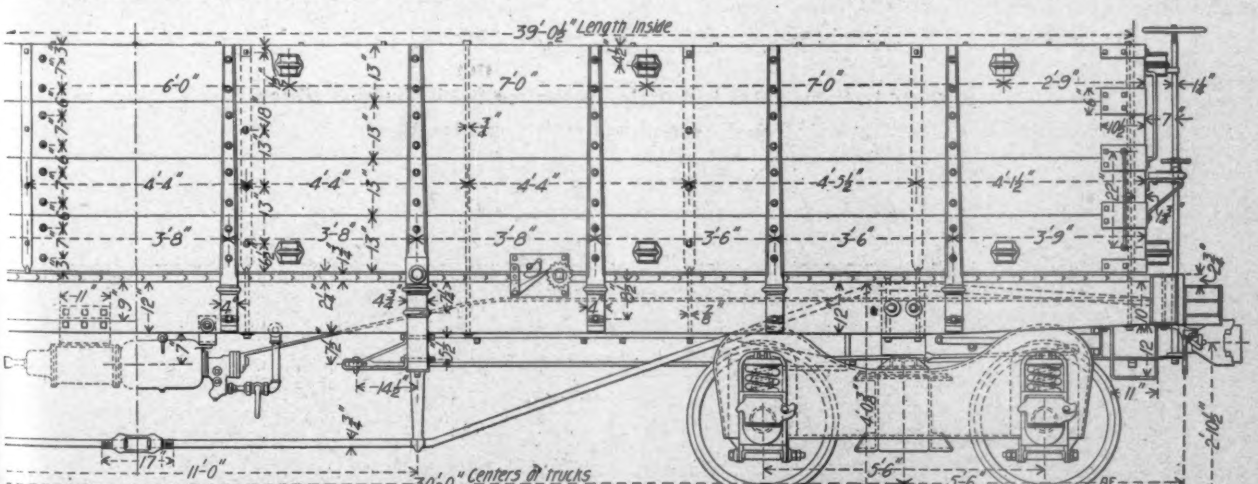
MAY, 1900.

CONTENTS.

80,000 AND 85,000-POUND COAL CARS.

Buffalo, Rochester & Pittsburgh Railway.

Several designs of wooden cars of large capacity for carrying coal and coke have been made by Mr. C. E. Turner, Superintendent of Motive Power of the Buffalo, Rochester & Pittsburg Railway, and we have received the drawings of two of the coal cars. These cars are for widely different purposes, the treatment being far different in the two cases. The



80,000-Lb. "Shovel Car"–Buffalo, Rochester & Pittsburgh Railway.

Half Side Elevation.

80,000-pound car is for use in transporting coal for unloading at station team tracks, and is designated a "shovel car" because it is low sided for convenience in unloading by hand when the drop doors cannot be used. The 85,000-pound car is for use in dock and trestle service and is called a "dock car." Both were designed to fit the clearances of the road, which are limited by sheds and other obstructions, the problem being to secure the necessary volume by keeping within the necessary limits of height and length. The length is limited by sharp curves. The height from the top of the rail to the under faces of the sills at the ends is unusually low, being but 30 inches in the dock car and 30½ inches in the shovel car, when measured at the ends. This height is usually more than 36 inches. The chief dimensions of the two designs are indicated in the following table:

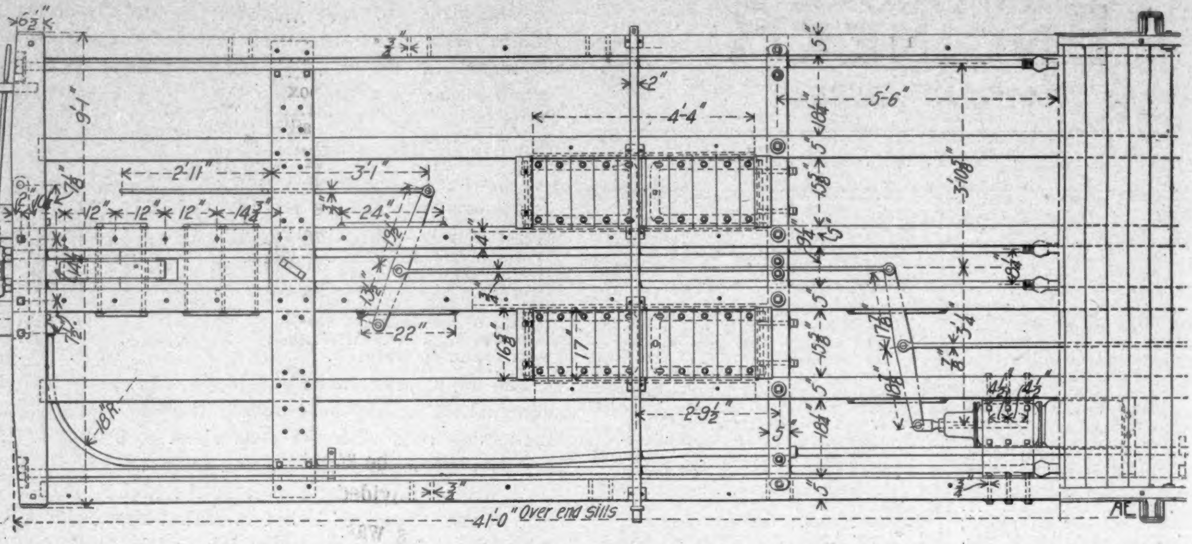
General Dimensions.

	Hopper car.	Shovel cars
Length over end sills	32 ft. 6 in.	41 ft. 0 in.
Length inside of box	30 ft. 6 in.	39 ft. ½ in.
Width over side sills	9 ft. 3 in.	9 ft 0 in.
Width inside of box	8 ft. 5 in.	8 ft. 5½ in.
Height rail to top of box	9 ft. 1⅛ in.	8 ft. 6 in.
Height over all	9 ft. 6 in.	8 ft. 11¼ in.
Height to bottom of sills	30 in.	30½ in.
Height of box inside	5 ft. 0 in.	52⅝ in.
Door openings, length	3 ft.	4 ft. 4 in.
Door openings, width	3 ft. ⅝ in.	17 in.

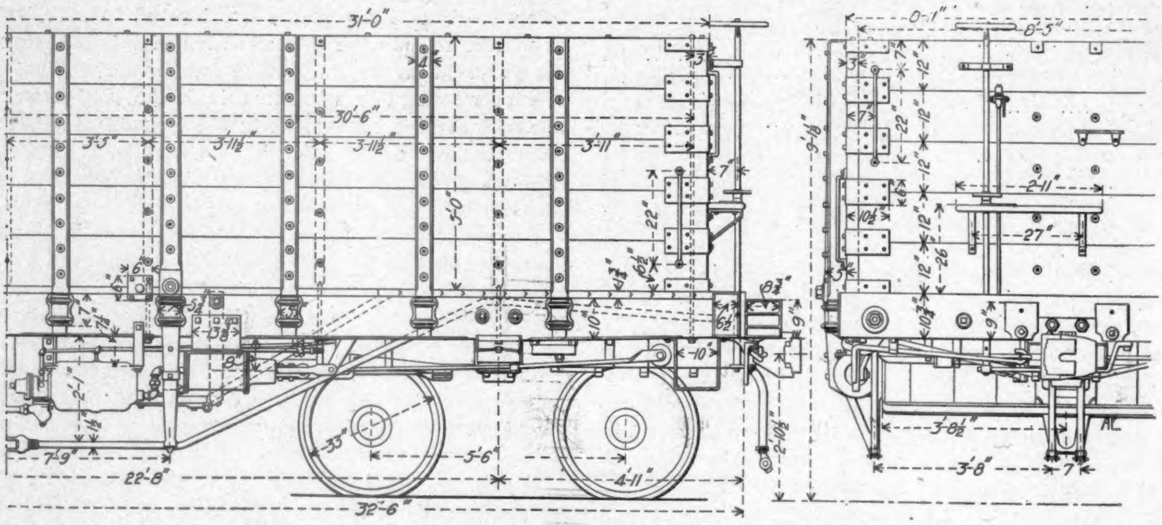
The shovel cars were developed from gondolas, without the doors, these having been added afterward. There are four 1¾-inch truss rods with the ends upset to 2 inches. The trusses are 36½ inches deep, measured from the center of the rod at its lowest point to the center at the highest point. The lower line of the truss rods is but 10 inches above the rail. The bolsters are of plate construction, with malleable-iron filling pieces, and the depth of the truss is 19¼ inches. The side sills are 5 by 12 inches, and the four intermediate sills are 5 by 9 inches. The draft timbers are reinforced by 4-inch sub-sills, which are continuous. The draft gear is the Butler type, and the draft timbers may be taken down without removing the bolsters. The siding stakes are tapered to save weight, and, as will be seen in the side elevation of this car, stake pockets are provided for use in loading lumber. The greatest variety of uses was kept in mind in this design, and it was intended to make the car convenient in the iron ore, lumber and bark trades as well as for hauling coal, and in the coal trade the cars are unloaded either through the doors or over the sides. This car has Fox pressed steel trucks.

The dock car is of the gondola type, with a single shallow hopper extending 24 inches below the floor line. It has four 1½-inch truss rods arranged in a truss that is 35 inches deep, measured from the offset in the truss rods. This is a short car for its capacity. The sides are high, however, and the body is low, which accounts for its large capacity within the limits imposed. This car is a development of a former design for 80,000 pounds capacity, which was 28 feet 6 inches long inside. The increased capacity was obtained by adding 2 feet to the length. About 1,000 of these cars are now running in the coal and ore trades. They haul coal in one direction and return loaded with ore. One of them has been loaded with 132,000 pounds of iron without running hot on bringing the side bearings into contact. The arrangement of sills and other floor timbers is clearly indicated in the engravings.

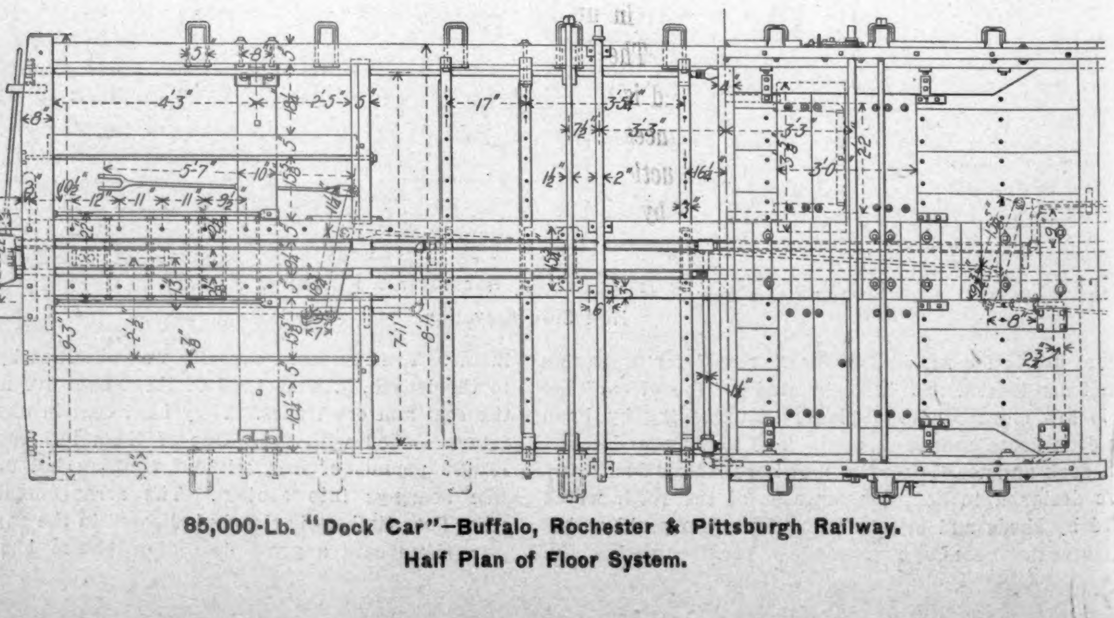
In these cars a great deal of attention has been paid to



80,000-Lb. "Shovel Car"—Buffalo, Rochester & Pittsburgh Railway.
Plan of Floor System.



85,000-Lb. "Dock Car"—Buffalo, Rochester & Pittsburgh Railway.
Half Side Elevation and Half End Elevation.



85,000-Lb. "Dock Car"—Buffalo, Rochester & Pittsburgh Railway.
Half Plan of Floor System.

malleable castings with a view of obtaining the complete benefits from light weight which they offer. The elastic limit of malleable iron was taken at 30,000 pounds per square inch, and the ultimate strength at 40,000 pounds, the calculations being made with a view of keeping the fiber stresses down to 4,000 pounds per square inch. The malleable castings for these cars of 80,000 and 85,000 pounds capacity weigh less than the gray-iron castings formerly used in 40,000-pounds capacity cars, and a saving in weight of about 43 per cent. is effected by using malleables.

FOUR-CYLINDER COMPOUNDS.

Prof. Goss, after an extended European trip last year, when he made a careful study of practice and tendencies in railroad work, in commenting on the compound locomotive, said that the four-cylinder type was the only one making progress either in England or on the Continent. It is noticeable that there is a tendency in the United States to believe that the possibilities in power and capacity of present methods are very nearly exhausted and inasmuch as four-cylinder compounds of a certain well-known type have given an excellent account of themselves here, there is reason to believe that the advantages of English and French four-cylinder compounds will be regarded with increasing interest in this country. It is believed by several well-known motive power men that the four-cylinder, balanced compound offers a greater ultimate increase in power than any other type. The reluctance

Webb's Four-Cylinder Compound for the Paris Exposition—London & Northwestern Ry.
4,000th Engine Built at the Crewe Works.
Fig. 1.

The Paris Exposition was formally opened April 14 by President Loubert with appropriate ceremonies and the affair was a brilliant success. The American section is well advanced toward completion. It will require at least a month to bring the whole up to a state of completion, and the motive power will not be ready until June. Space occupying 329,052 square feet has been allotted to this country.

Fig. 2.—Photograph of Main Driving Wheels and Crank Axle.

Fig. 3.—Photograph of Rear Driving Wheels and Axle.

to increase the complication and the number of working parts may defer a thorough trial of the type here for a time, but when a carefully designed engine of this kind is built and tried, this objection will probably be found less serious than it now appears. We believe in utilizing present designs to the limits of their possibilities and in keeping in mind the fact that further progress must be provided for.

Because of Mr. F. W. Webb's work in four-cylinder compounds and the success he has obtained with the principle on the London & Northwestern we asked him to permit us to illustrate the vital feature in their construction, the crank axle, and he kindly furnished the accompanying photographs and drawing. Fig. 1 is from a photograph of a new four-cylinder compound express passenger engine, "La France," which has been sent to the Paris Exposition, and is the 4,000th engine built at the Crewe Works, nearly the whole number of which Mr. Webb has seen constructed. This engine is identical with others of the four-cylinder type designed by Mr. Webb. In reading the article on page 1 of our January issue of this year the impression may have been received that the central frame originated on the Lancashire & Yorkshire. This is not the case, however. Mr. Webb's drawing, from which Fig. 4 was made, bears the date of November 30, 1886. Since that time this idea has been used in every London & Northwestern engine to which it was applicable. A great deal of trouble was taken in working it out to render the central axle box easy of adjustment with the other two boxes and without unnecessary refinement. The central frame is a deep cast-steel girder reaching from the guide yoke to a cross brace at the rear of the main axle. It furnishes a third bearing for the axle, which is in equilibrium between the springs. It is not expected to aid in carrying weight but to serve to aid in receiving the thrusts from the pistons. The wheel seats of this axle are 8½ by 6½ in., the main driving journals are 7 by 9 in., the crank axle journals are 7¾ by 5½ in. and the absence of eccentrics, due to the use of the Joy valve gear saves the space ordinarily occupied by these parts for other purposes. Fig. 4 shows the application of the central frame to six coupled freight engines with 18 in. cylinders and 60 in. wheels. The outer springs in this design are of ⅝ in. square steel with left-hand coiling, while the inner springs are coiled the other way and are made of 7/16 in. square steel. These springs are 9⅛ in. long before compressing.

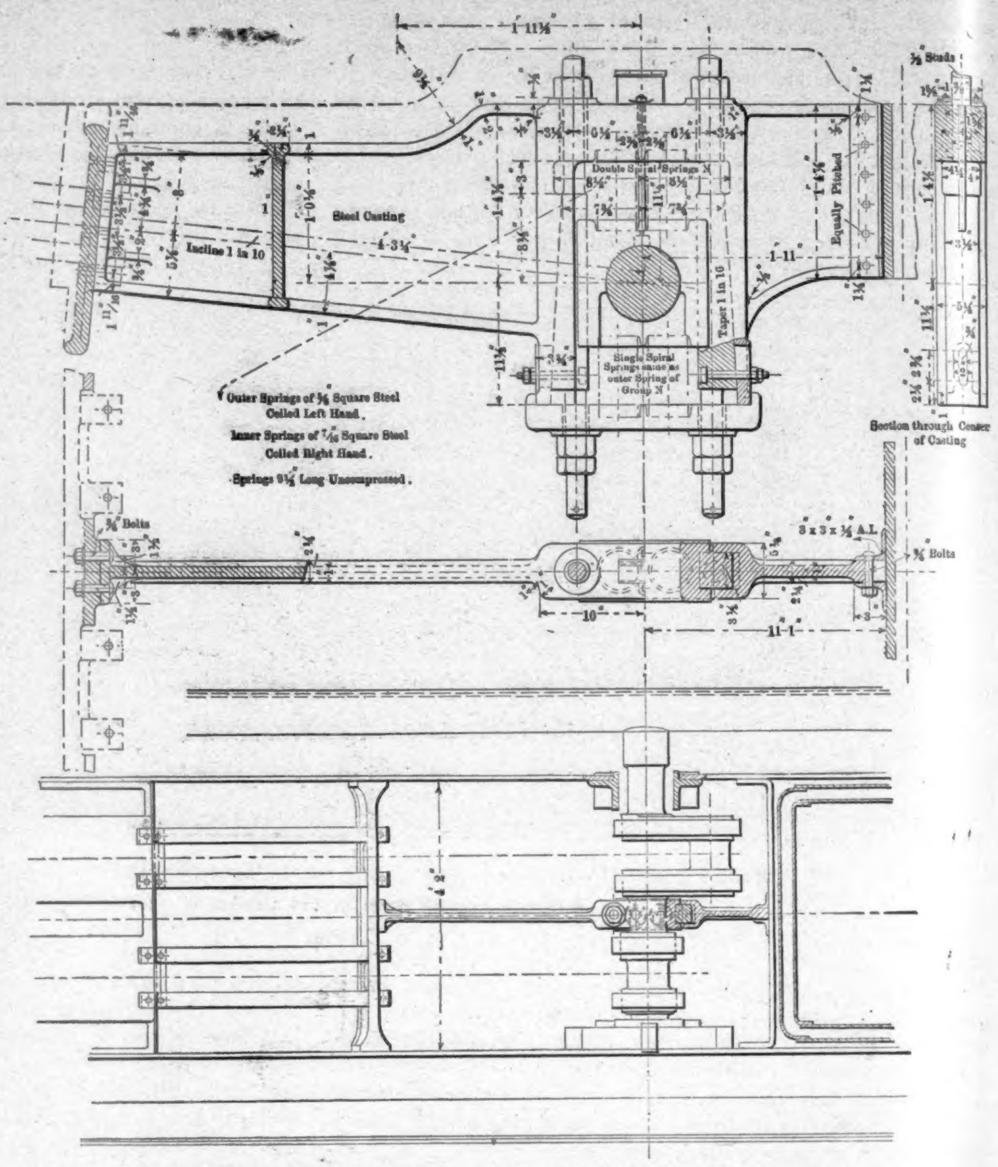


Fig. 4.—Webb's Central Frame for Four-Cylinder Compounds.

Photographs of the main and rear driving wheels and axles are shown in Figs. 2 and 3. These show the driving journals, which are large for English practice and for which this construction provides. The method of balancing both pairs of driving wheels is shown in the photographs. Mr. Webb finds no difficulty in casting these 7 ft. 1 in. wheels, and does not find it necessary to cut the rims as is generally done in this country to prevent the spokes from contracting away from the rim. It will be observed that the axle is built up. This permits of using qualities of steel for each part that are best adapted for its purpose. The crank arms are of nickel steel, while chrome steel is used for the bearings, and crank pins. With special tools for making them, these tools cost but little more than if forged solid and cut out in the usual way.

These engines have two 15 in. high-pressure cylinders outside of the frames and two 20½ in. low pressure cylinders, all having 24 in. stroke. One pair of cylinders on each side, including one high and one low pressure cylinder is operated by a single valve gear, the motion for the low pressure valves being transmitted by a rocking lever from the front end of the high pressure valve stem.

The House Naval Committee has reported an appropriation of over $61,000,000 for expenditure upon the navy this year. Last year the appropriation was $64,354,000, and these large sums indicate a new and liberal policy. In its report the committee directs attention to our naval advancements as follows: "We have a navy to-day which includes a considerable number of vessels of every class, and ship for ship it will equal that of any navy in the world. Seventeen years ago we had practically no facilities for building ships, and what we had were discredited. We were obliged to buy our armament and armor, and even in one case our plans, from foreign countries. To-day we are not only building ships in American shipyards, of American material, by American labor, on American plans, for ourselves, but also for some of the leading nations of the world. Such has been the advance which has been made in naval progress in our own country."

The Pullman Co. is introducing a patented cement flooring for cars, called "Monolith," which is controlled by them and is used on their own cars and also on passenger cars belonging to railroads. The material consists of cement, plaster and sawdust mixed with a liquid, the nature of which is kept a secret. It is spread uniformly to a thickness of about ½ in. and is reported to be hard, light and waterproof when dry; surface being smooth and easy to clean. It is being tried experimentally on the Union Pacific on a number of cars.

An interesting fact in connection with the new overland train which the Burlington is about to put into service between St. Louis and Puget Sound, by way of Billings, Mont., is that for nearly the entire distance of 2,500 miles it will run through country acquired by the United States at the time of the Louisiana purchase in 1804. When Napoleon Bonaparte, on behalf of France, sold the territory to us for about 2½ cents an acre, he little dreamed, in his endeavor to annoy England, what a magnificent empire he was practically giving away.

Iron is said to have been melted in five seconds in a recent experiment carried out by Mr. Louis Dreyfus at Thomas A. Edison's laboratory, at Orange, N. J. Mr. Dryfus represented the Goldschmidt Chemical-Thermo Industrie of Essen, Germany. He covered an iron wrench in a crucible with a chemical of secret composition and added a small quantity of powdered aluminum. The wrench, which was 6 in. long and ½ in. thick, was melted in five seconds after the chemical was set on fire, the temperature being estimated at 3,000 degrees C. The process is suggested as being applicable to the melting of rails and pipes.

The Master Car Builders' and Master Mechanics' Association's headquarters for the conventions to be held during the week of June 18 will be at the Grand Union Hotel, Saratoga. Liberal space for exhibits has been arranged for by the standing committee and allotments may be made by addressing Mr. Hugh M. Wilson, 1660 Monadnock Building, Chicago. Applicants for space should state whether they desire it upon the verandas or in the open court. The heavy machinery must be placed in the court. Steam will be piped to a central point in the exhibit space, and exhibitors requiring steam will be at liberty to connect their ipiling to it and will furnish their own piping and fittings. Electric current may be had from the city wires upon application to the proprietors of the Grand Union Hotel.

"Railway Bearings; A Study in Structure," was the subject of a paper read before the Franklin Institute at the April meeting, by Mr. Robert Job, Chemist, Philadelphia & Reading Railway, Reading, Pa., the author of the article upon the same subject in our issue of February, 1900, page 38. Results were given of an investigation of bearing metals to determine sources of excessive friction, and also to find out by experimentation the foundry practice by which such defects were produced, as well as the methods and manipulation necessary to ensure the most efficient results, in order to establish in the foundries of the Philadelphia & Reading Railway a thoroughly serviceable standard practice, as free as possible from observed defects. In order to gain information, a large number of bearings which had run hot and had been removed from cars of other roads while passing over the Philadelphia & Reading Railway, were examined physically, analytically and microscopically, and the defects observed were shown upon a number of lantern slides from photographs and photo-micrographs prepared in the course of the investigation. The principal defects found were: 1st, segregation of the metals; 2d, crystalline structure; and 3d, oxidation products and occluded gas in the metals. The causes by which each defect was produced were given in detail, and also the methods by which each might be avoided, giving also the standard practice which has been worked out by means of this investigation, and is in successful operation upon the Philadelphia & Reading Railway. Results of practical service tests of different metals were also shown, and a comparison between the physical tests and the practical efficiency found in service.

PREVENTION OF WEAR OF DRIVING WHEEL FLANGES.

The wearing of driving wheel flanges has always been troublesome and the fact that several roads have found it necessary to give special attention to it recently indicates that it is not entirely a question of the past. Roads differ in the extent of this trouble. Nearly all roads are very often obliged to turn off tires on account of flange wear and whenever this is necessary a lot of steel from the treads of the tires must be cut out in order to secure a full flange again. It is safe enough to say that a sure method for preventing flange wear will be welcomed by every superintendent of motive power.

The Atlantic Type fast passenger engines Class E1 of the Pennsylvania have a new feature which has a bearing upon this subject. We noted on page 23 of our January issue, in describing this engine, that the center pin of the leading truck was placed 9½ in. back of the center of the wheel base of the truck, which was done in order to relieve the front truck wheel flanges of a portion of the impact which they ordinarily receive. This increases the leverage of the forward wheels in guiding and it probably also would have a marked effect upon the leading driving wheel flanges if the engines were provided with them.

The advantages of the form of locomotive truck hanger recently adopted on the C. B. & Q. R. R. is well understood. There is nothing new about it, but the prevailing practice of using inclined links indicates that the three-point hanger is not appreciated.

On this road the question of truck hangers for mogul engines was raised by worn flanges and by several derailments, not of the trucks, but of the forward driving wheels. These occurred on rough track and led to a careful series of experiments upon the motion of the engines relative to the trucks in taking curves. The derailments appeared to be due to the peculiar action of the inclined link hangers and the insufficiency of the truck in guiding the locomotive. The swing links were 21 inches between centers at their upper ends and 23 inches at the lower ends, and about 8 inches long between centers. A rough sketch of the position of the links when the engine takes a curve, shows the disdvantages of this plan and its deficiency in guiding power. A side movement of one inch brings one of the links to a vertical position, while the angularity of the other is increased. The guidance of the engine then comes upon one link and the center casting frame is tilted.

An arrangement which will act as a parallel motion and serve as a powerful guide to the front end is required. This is best secured by three point hangers, the principle of which was favorably reported upon by the Master Mechanics' Association in 1896.

The heart-shaped hanger shown in the accompanying engraving, Fig. 1, resulted from the investigation on the Burlington. Its form is clearly indicated, and special attention is directed to the distance between the centers of the upper pins. This was made 3 inches at first and was increased in order to increase the power of the truck to guide the engine and relieve the driving-wheel flanges. This distance on the consolidation engines of the Pennsylvania, Class H5 and H6 is 3½ in., as shown on page 184 of our issue of June, 1899.

Now that 6 by 12-inch truck journals are coming into use it will not always be easy to find room for such hangers, but their unquestioned value warrants efforts to use them and for four wheel as well as two-wheel trucks.

The sharpening of flanges on the leading driving wheels of a locomotive indicates that the truck does too little guiding, and the sharpening of the flanges of the truck wheels indicates that they do too much guiding. Opinions differ as to how to adjust this effect and the discussion of the relative values of different methods of arranging hangers, as presented on page 321 of the Proceedings of the Master Mechanics' Association for 1896 is appropriate here. Figs. 3 to 10 are reproduced from that record as showing the methods of arranging swinging links which are in common use. In Fig.

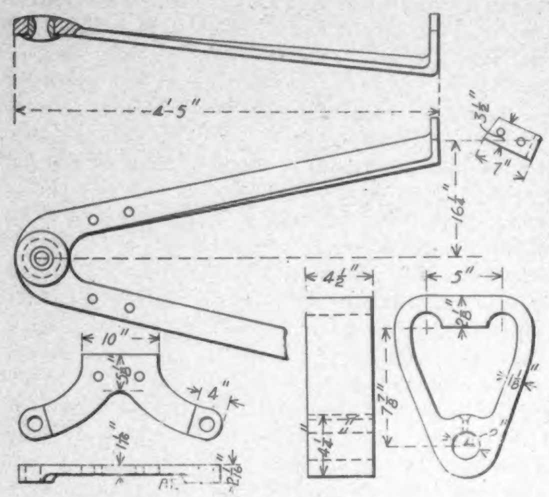


Fig. 1.—Three Point Truck Hangers.—C., B. & Q. R. R.

Fig. 3. Fig. 4. Fig. 5. Fig. 6.

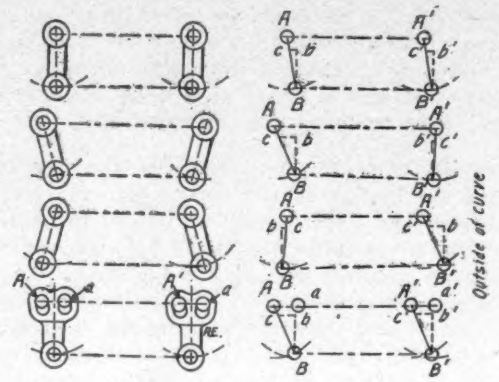


Fig. 7. Fig. 8. Fig. 9. Fig. 10.

3 the links are perpendicular, in Fig. 4 the upper ends are further apart than the lower ends, while the reverse arrangement is shown in Fig. 5. The three point hanger is shown in Fig. 6, this being similar in principle to the C., B. & Q. hangers of Fig. 1. The action of the various hangers appears in Figs. 7 to 10, in which the center lines of the links only are represented and the outside of the curve is supposed to be at the right side of the engraving. When an engine with swinging links strikes a curve the bolster B B¹ tends to move toward the outside rail, and this swings the lower ends of the links toward the right. Without going into the details these diagrams

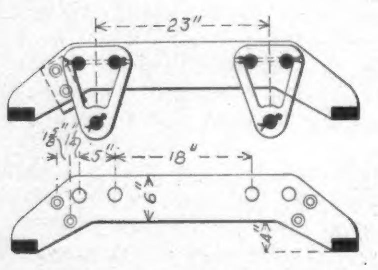
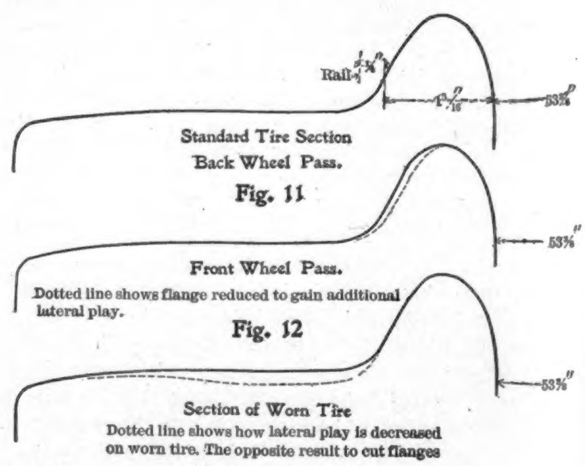


Fig. 2.—Truck Hangers.—C., B. & Q. R. R.

clearly indicate the importance of keeping the links parallel. The three point hanger does this and its advantage in the tendency to return to its normal position is shown by the length of the line cb and c¹b¹ in Fig. 10 as compared with the corresponding lines of the other diagrams. If from the centers B B¹ in Fig. 7 perpendicular Bb and B¹b¹ are erected, whose length will equal the weight resting on the lower ends of the hangers, the horizontal lines c b and c¹ b¹ drawn from their upper end to the center lines of the hangers will represent the lateral pressure exerted by the weight resting on the hangers. In Figs. 8 and 9 the lateral forces exerted by the links actually oppose each other. This is a strong argument in favor of the three point hanger.

On the Lake Shore & Michigan Southern, which has a comparatively straight track with maximum curves of 6 deg. on the main line, a very simple method was applied to the new consolidation engines built by the Brooks Locomotive Works (see February, 1900, page 37), from a suggestion by Mr. John Player, Mechanical Engineer of the works. The pony truck is expected to do its share of the guiding, and the driving wheels,



Standard Tire Section
Back Wheel Pass.

Fig. 11

Front Wheel Pass.
Dotted line shows flange reduced to gain additional lateral play.

Fig. 12

Section of Worn Tire
Dotted line shows how lateral play is decreased on worn tire. The opposite result to cut flanges

Fig. 13

Line Sections—D., L. & W. R. R.

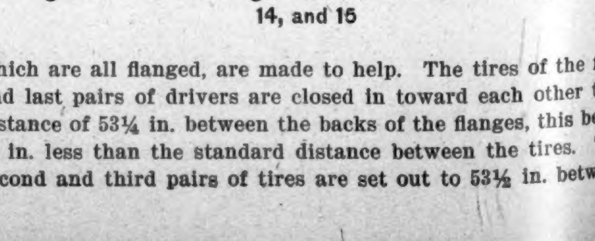
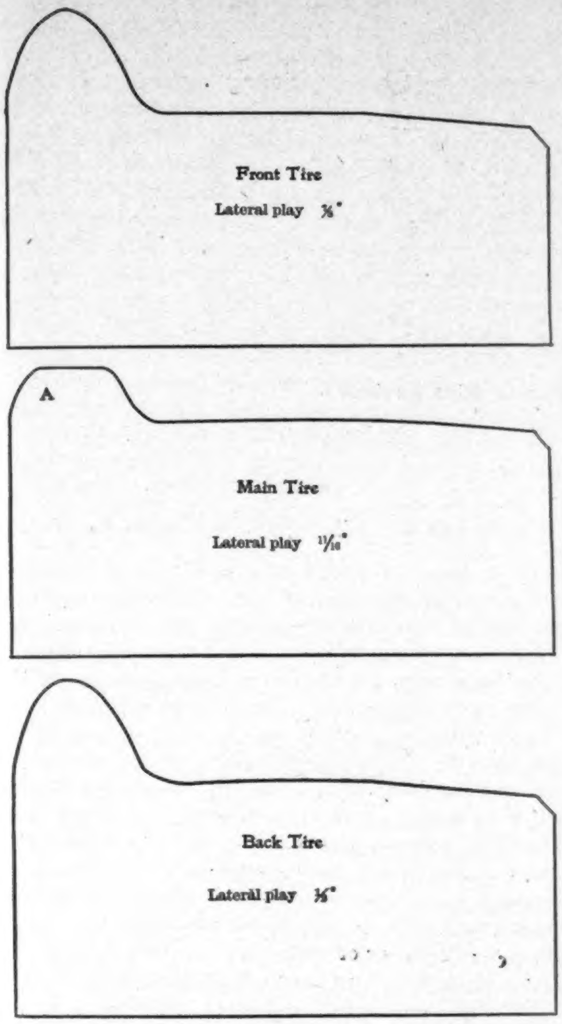
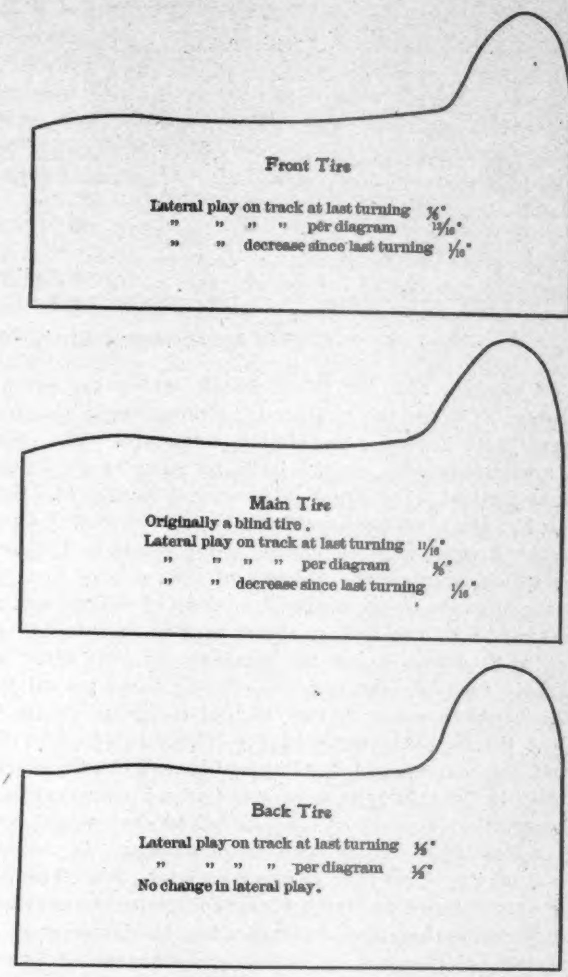


Fig. 16.—Wheel Arrangement of Locomotive of Fig. 3, 14, and 15

which are all flanged, are made to help. The tires of the first and last pairs of drivers are closed in toward each other to a distance of 53¼ in. between the backs of the flanges, this being ⅛ in. less than the standard distance between the tires. The second and third pairs of tires are set out to 53½ in. between





TIRE SECTIONS FROM 10-WHEEL LOCOMOTIVE—D. L. & W. R. R.

Fig. 14.

When this engine was received from the builders the main tire was "blind." After two tire turnings the flange "A" was formed.

Fig. 15.

After 16 months, 8 days' service, during which the engine ran 71,930 miles, these sections of the tires were taken.

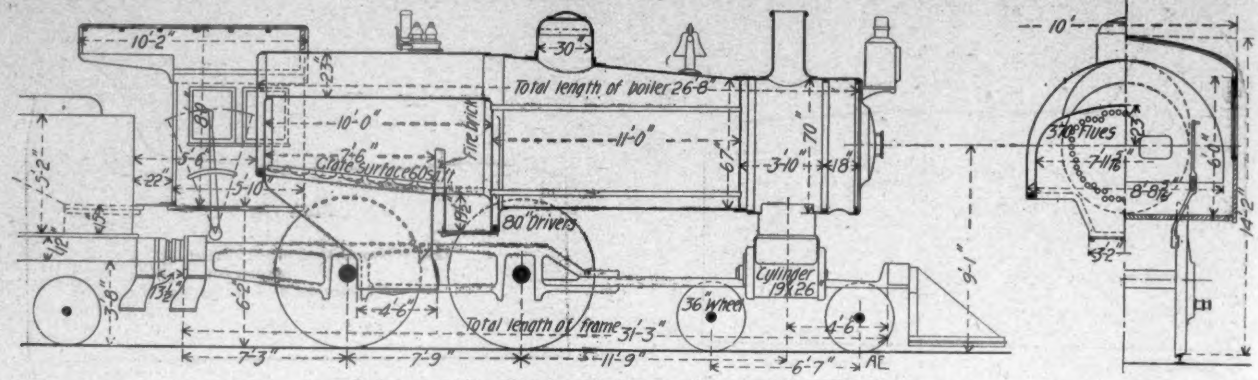
the backs of the flanges, which is ⅛ in. more than the standard distance. With this arrangement the second and third pairs of flanges will do some of the guiding. The effect appears to be to give the same result as far as the wheels are concerned as is obtained by the wear of the flanges in service. Mr. Marshall expects good results from this arrangement.

Those who have not been aware of the practice of the Delaware, Lackawanna & Western R. R. will be interested to know that for 30 years this road has had no trouble with worn flanges and has used flanged tires on all wheels during this time. Readers may at first be incredulous when we say that on this road the driving wheel flanges grow thicker at the throat as the tires wear, but those who take the trouble to inspect the tires in use and on the scrap piles of this road will be convinced, as was our representative, that this is true. While the plan has been repeatedly mentioned before the Master Mechanics' Association, it, as far as we know, has never been described. We do not say that equally good, if not exactly the same results can not be obtained in other ways, but that the method used on this road is successful in stopping flange wear appears to be certain.

Mr. W. C. Conwell, who has been foreman of the Scranton machine shops of this road for 45 years, made a study of this subject long ago in connection with the reduction of the gage of tracks from six feet to the present standard. When this was done much trouble was experienced because of very rapid wear of flanges and Mr. Conwell made a very thorough analysis of the causes. He soon saw that the plain tire did not contribute to the guiding of the engine and that in consequence it threw heavy responsibilities upon the flanges of the other wheels. He then made up his mind that the problem could be solved by putting the tires, when new, into the condition as to lateral play into which they were brought by wearing. By "lateral play" we do not mean the longitudinal play of the driving journals in the boxes, but the play of the wheels with reference to the gauge of the track. The total lateral play at the driving boxes on this road is 3/16 in. which is 1/16 in. less than is usually provided.

Through the courtesy of Mr. J. W. Fitz Gibbon, until recently Superintendent of Motive Power of the Lackawanna, we are permitted to describe this interesting practice, which consists of making the distance between the inside faces of all tires a standard of 53⅜ in., the lateral play of the wheels upon the rails being different for the various axles, this play being provided for by the thickness of the flanges. The distance between tires was made to suit the guard rails, and the questions concerning the inside and outside of the tires were considered separately.

The simplicity of the plan appears in the diagrams. Fig. 11 shows the original tire section for the rear wheel of a 4-wheel connected passenger engine in which the lateral play is ¼ in. on each side, or a total of ½ in. The dotted line in Fig. 12 shows the form of the flange of the front wheel to secure the amount of lateral play required. This principle applies to all



A Locomotive Study.—A Suggestion in Wide Fireboxes.

classes of engines and for those wheels which are given a lateral play of ½ in. the tire section differs very little from the Master Mechanics' Association standard. The other flanges are pared down on the lathe to make them thinner. The usual method of wearing is indicated in Fig. 13. On a number of engines which have been in service from 15 to 20 months the flanges were found to be thickened at the base, Fig. 13, which reduced the amount of lateral play and was exactly the opposite to cut flanges. In some of the cases of old tires, examined by the writer, the flanges were reduced very slightly in thickness below the original size, but there was not a single case of "cut flange." In the large majority of cases the flanges remain at the original thickness or are increased at the base as shown in Fig. 13. Engines with this tire treatment have made 150,000 miles between tire turnings.

As shown in the table, the wheels of 4-wheel trucks are made with the smallest amount of play, ¼ in. on each wheel, with a view of making the truck do a lot of guiding. In the case of pony trucks 3/16 in. play is given on each side. The purpose of the difference in play among the driving wheels is by allowing considerable play to make the leading drivers do some of the guiding and by giving less play to the second, third and fourth pairs to make each pair do its share. The rear wheels of the four and six coupled engines are made with the least amount of play in order to "center" the rear end of the engine on the track, and in the 8-coupled engines the front and rear wheels are given the same amount of play in order, as Mr. Fitz Gibbon puts it, to "make the engines fit the curves."

The rule for the allowance of the flange play is as follows:

Mogul type....Front wheels, ⅞ in; main wheels, ⅝ in.; back wheels, ½in.
Eight-wheel type .. front wheels, ¾, in.... back wheels, ...½ in.
Consolidation..Front and back wheels, ⅞ in.; second and third, ⅝ in.
Engine truck wheels (4-wheel truck)..................................½ in.
Engine truck wheels (pony truck) ....⅜ in.
Total lateral play at driving box hubs ....3/16 in.

It has been argued that the same result may be obtained by giving the play or side motion in the axles by making these allowances in the play between the driving wheels and the driving boxes, instead of having it between the flanges and the rail. Whether this is true or not, it is evident that the effect of the D., L. & W. method makes the wheels fit the rails easily on curves, and it is apparently entirely satisfactory. The locomotive trucks on the main line of this road are all of the swing motion type. Mr. David Brown, Master Mechanic at Scranton, informs us that the flanges of the driving boxes are tapered on the inside from the top and bottom to permit the boxes to tip with the axles as they take the elevation of the outer rail on curves. The central portions for a length of 3 inches are parallel, while the top and bottom of the opening is ⅛ in. wider than the central portion.

Some of the engines on this road make 11,000 miles per month in regular service which indicates that they are not petted. The plan is now on record and we shall be glad if the description calls out the comment of readers.

Mr. G. W. West, Superintendent of Motive Power of the New York, Ontario & Western, has used for some years an adaptation of the D. L. & W. plan. He places the tires of the forward and rear wheels a little closer together than the middle ones of ten-wheel and consolidation engines. The middle wheels are kept at the normal distance.

A LOCOMOTIVE STUDY.

By Edward Grafstrom.

Mechanical Engineer Illinois Central Railroad.

While it does not represent a new type of locomotive, the accompanying engraving may be of interest as showing a novel adaptation of the wide firebox to a fast passenger engine of the American type. This has not been attempted heretofore, at least not in this country, except to the extent of the Belpaire firebox, reaching over the frames, though not over the drivers.

The Atlantic type of engine came into existence to meet the conditions essential to the modern high-duty express engine, which are summed up in the expression, sustained speed. Not the burst of speed which a little 18 by 24-inch engine occasionally makes over a level stretch, nor the rushing along of an "extra" with three or four cars, on a special schedule; but the speed that tells, the steady pull day after day, regardless of weather conditions or of extra cars, at a scheduled 50-mile gait, that can be forced 50 per cent. when there is lost time to make up. For such work steam is needed, and lots of it, but every pound of water evaporated requires a certain quantity of coal, and every pound of coal burnt needs a certain amount of grate area, and thus the problem has resolved itself into two controlling elements: grate area, and muscle wherewith to supply the same with coal.

It is not the purpose here to expostulate on the merits of the Wootten firebox or its modifications. Suffice it to say that it has been resorted to when the Belpaire or radial stay type reached the limit of length at which a fireman's coal shoveling ability ceases. The Atlantic type of engine is, as already stated, the outcome of this demand for grate area in combination with large drivers, and from an engineering point of view, purely, it answers the purpose well enough. The principal objection to it is that the engineman has to be entirely separated from his fireman. Several instances are on record pointing to the great risk of entrusting the lives of a number of passengers to the care of one mortal man, and he beyond the reach and observation of others perhaps for half an hour or more at a time.

In October, 1898, an Atlantic type engine on an Erie night express ran ten miles with a corpse at the throttle, before the fireman became aware of the situation. Three years ago a similar instance happened on the Philadelphia & Reading, and it is still in fresh memory of many New Yorkers how a pilot was found dead at the wheel of a ferry boat, since which it has been compulsory to carry a second man, usually a deck hand, in the pilot house of the ferry boats. If the writer is correctly informed, legislation has also been evoked in some western States, practically making engines with cabs in front of the firebox prohibitory, unless an extra man rides in the cab with the engineman. Admitting that such cases are rare, there still remains an element of security in knowing that two men can compare notes when indistinct signals and train orders are of doubtful meaning.

The idea embodied in the design shown in this connection

is of foreign origin, but is equally applicable to the 10-wheel and the American type of engines in use in this country. Without describing the design in detail, attention is called to the combustion chamber between the flue sheet and the bridge wall, which may be cleaned out through the drop door at the bottom. This door, it is thought, will also permit of the caulking of flues and similar work without tearing down the brick arch or waiting for it to cool. The rear end of the cab has been left open, as the heat radiating from such wide fireboxes is, as a rule, considerable, regardless of how completely the boiler inside the cab is lagged. The raised floor in the coal space of the tender has already been found necessary on several recent 10-wheel engines, and is not objectionable.

In conclusion it should be said that the design is merely a study in a somewhat new line, open for criticism and possibly further developments, and it is offered as a suggestion and not as a finished product.

STATIONARY SHOP BOILERS.

A contrast of stationary boiler practice, showing the advance of twenty years, is to be seen in two adjacent boiler rooms of a certain railroad shop. One, just completed, is equipped with modern water-tube boilers, with automatic stokers, and machinery for handling coal and ashes, and the other, which is soon to go, has a lot of old locomotive boilers. The first represents the thought and care of the mechanical engineer, and the other is a type of practice for which no favorable argument can be advanced. This plan, however, does not require requisition or correspondence, and this probably explains its existence. There is an awakening to the possibilities for improvement which is shown by the recent installation of a number of thoroughly up-to-date boiler plants in railroad shops, and by the appointment of a committee to consider the "Best Type of Stationary Boiler for Shop Purposes," for report at the approaching convention of the Master Mechanics' Association.

We do not wish to be understood to advocate the investment necessary for coal and ash-handling machinery, mechanical draft, or automatic stokers, in all cases. These are advantageous only under certain conditions, and these are determined chiefly by the size of the plant. But what we do advocate is a thorough treatment of the subject of steam production in the plans for new shops and the rebuilding and extension of old ones.

In the circular of inquiry issued by this committee the first question is as follows: "From your experience, do you prefer locomotive type boilers with internal fireboxes, return tubular boilers bricked in, or water-tube boilers?" The selection of the type of boiler is most important, and the three most recent examples of improved shop practice testify to the advantages of the water-tube type. In the matter of repairs, especially, it is to be hoped that the replies from members will show the relative costs of various types. In this connection it is interesting to know that water-tube boilers have been in constant use in large batteries for more than ten years without costing anything for repairs.

Water-tube boilers are usually capable of being forced far beyond their rated capacity, but with this exception it is possible to select a water-tube boiler which is really inferior to a return-tube boiler of the common form. The rapidity of steaming and of getting up steam pressure, together with the possibilities of greatly increasing pressure while keeping within the limitations of weight, have brought the water-tube boiler into the naval practice of several governments. The rapidity of getting up steam pressure has been strikingly expressed by some one, who has said that if English naval vessels had tank boilers and French vessels had the water-tube type, and fleets of both nations lay at anchor on their respective shores of the English channel, with the boilers all cold, the French fleet could reach the shores of England before the English ships could move from their anchorages.

The matter of weight is not important in stationary work, but the rapidity of steaming, and the ready response to sudden fluctuations in the demand for steam, have brought this boiler into electrical distribution practice, until we now see this type selected for the enormous aggregations in the power plants now under construction for the most extensive electric railroad systems in the world. The concentration of steam and electric power generating plants into one power house is now the rule in the construction of large shops, and this involves the use of power all over the plant for work that was formerly done by independent steam plants or by hand. This will naturally be accompanied by considerable fluctuations of load, which will require corresponding flexibility in the production of steam, so that the water-tube boiler meets the same requirement in the shop as in the electric railway power house.

The evaporation of water per pound of coal, of course, depends upon the coal, but in a well-designed water-tube boiler the ratio may be expected to be from 5 to 10 per cent. greater than in the return-tube boiler, with the same quality of coal in each. With Pocahontas coal, over 11 pounds of water per pound of dry coal, from and at 212 degrees, have been evaporated in a water-tube boiler. In forcing, these boilers have given satisfactory economy when burning as much as 35 pounds of coal per square foot of grate per hour.

It is not enough to speak of water-tube boilers as a type because of the great differences in the representatives of the type and in the selection. Burtin, in his "Marine Boilers" (page 233), divides them into three distinct groups, (a) those with limited circulation, (b) those with free circulation, and (c) those with accelerated circulation, the question of circulation being considered by him as one of fundamental importance. It is a vital factor in a steam boiler that the water should circulate, and this is one of the ways in which the cylindrical and locomotive types are defective. It has not been given its place in boiler design, and the water-tube boiler has been an educator in this direction.

Other considerations in the selection of boilers may be mentioned as follows: (1) The division of the water space into relatively small sections, with a view of confining a possible rupture to a small portion through which the pressure may find relief without danger of explosion. (2) Accessibility of all parts for cleaning and repairs. (3) Removal of the joints from the direct influence of the fire and provision for collecting mud in a drum that is removed from the fire. Of these probably the most important are those concerning the division of the water space and the accessibility for repairs. There appears to be an advantage in straight over curved tubes, and of course stayed surfaces should be avoided. Straight tubes are easier to clean than curved ones, as well as being easier to replace, and it is clear that a few tubes may be carried in stock for replacement in boilers in which all the tubes are straight and of the same length, whereas a much larger number must be available if they are of different lengths and curved differently. Furthermore, it is important to be able to get at tubes from both ends for cleaning.

Superheating is, perhaps, too great a refinement to expect for the present in shop practice, but when it has been reached another strong point of the water-tube boiler will be seen.

"The radical defect of prohibition is that it does not prohibit, of protection that it does not protect, of the radial stay that it is not radial, and of the cinder retaining extended smokebox that it does not retain the cinders." This was said by Mr. J. Snowden Bell in discussing the subject of locomotive front ends before the Western Railway Club. It is not so much a pessimistic expression as a warning to the effect that a name is not alone sufficient to make a device successful, and that we should not be satisfied when a thing is named.

Gas made in "Mond" producers capable of evaporating seven tons of water per ton of coal used was referred to by R. E. Crompton before the Institution of Electional Engineers (England) recently. This gas is equally applicable for use under boilers and in gas engines.

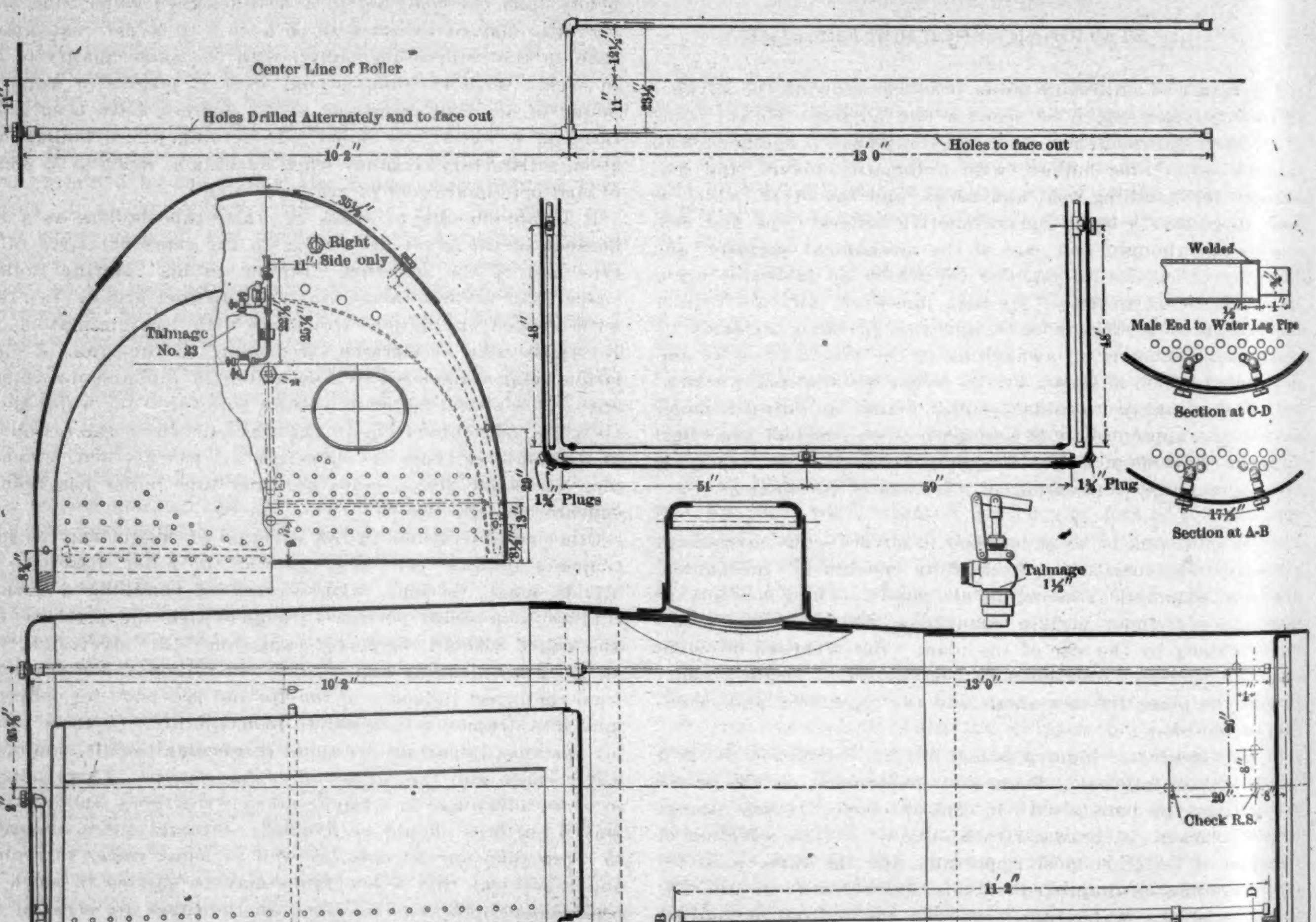
A SIMPLE AND SUCCESSFUL SCALE PREVENTION METHOD.

Erie Railroad.

Locomotive men have sought for years to find a satisfactory way to avoid the serious difficulties connected with the use of bad waters. Mr. A. E. Mitchell, Superintendent of Motive Power of the Erie Railroad, has tried a great many so-called remedies, including a long list of "patent medicines," and as a result of continued unsatisfactory experience he was naturally skeptical when a new plan was suggested. His characteristic thoroughness as an investigator, and confidence that oil could be used, led him to the study and development of the possibilities of the Talmage system, which we describe, and which is pronounced to be an unqualified success when properly operated.

Mr. J. G. Talmage, President of the Talmage Manufacturing Company of Cleveland, who had a long experience in the use of mineral oils in stationary boilers, was consulted by Mr. Mitchell in 1896 with reference to the application of oils in locomotive boilers. This led to some experiments which were not successful, but they indicated the desirability of using specially high test oils. This led to the preparation of what is known as "Rubra" oil, which is now regularly manufactured for this special purpose by the Talmage Manufacturing Co. It is a specially distilled hydro-carbon oil, entirely free from tarry and resinous matter. Its high fire test renders it safe in high-pressure boilers, and it does not decompose or form deleterious carbonaceous residues. The previous difficulty appeared to result from the distillation of the low fire test oil over with the steam, and raising the fire test to a point above the highest temperature of the water and steam immediately overcame the trouble. The system consists in feeding this oil into the boiler by means of a specially designed automatic feeder from which the oil is fed under control of the engineer. This feeder is generally placed on the left-hand side of the boiler head, within easy reach of the fireman. The system is completed by a number of blow-off valves used in connection with a system of perforated pipes. The arrangement of the system as applied to a standard wide firebox engine on the Erie is shown in the accompanying engraving.

The action of the oil is purely mechanical. It does not prevent the formation or precipitation of the incrusting solids, but when these are formed they seem to be at once enveloped in a film of the oil, which prevents them from sticking to the heating surfaces and throws them down in the form of mud, which may be blown out. The action of the oil is to surround the particles of the precipitated matter and prevent their crystals from cementing together or sticking to the heating surfaces. Before the application of the system the heating surfaces are coated with the oil. In this way the heating surfaces, including the crown sheets and tubes, are kept almost perfectly clean when the system is applied to a new engine. The oil prevents the corrosion and the pitting action of certain waters. The high fire test prevents the oil from vaporizing and distilling over with the steam, but the effect of the oil in the water is very marked upon the gauge cocks and blow-off cocks and the packings of the throttle stem, valve stems and piston rod, and also upon the wear of the cylinders and piston packing. These seem to



The Talmage System of Caring for Locomotive Boilers. Applied to Standard Wide Firebox Engine, Erie R. R.

be lubricated, and they are kept free from the precipitate. This is the testimony of the boiler makers and the engineers. Most careful examinations including chemical analyses of the scale from all parts of the boiler, show that the oil has no harmful effect whatever on the plates, and there is no corrosion of tubes or sheets. The heating surfaces in many of the waters appear to be black, and upon analysis it was found that this was due to iron from the water. Experiments to show the tendency to cause foaming developed the fact that even with the excessive feed of three gallons of oil in thirty minutes there was no foaming. Mr. Mitchell, fearing that some source of danger might be overlooked, even went to the extent of an examination of the oil with reference to the possibility of explosion in case a lighted lamp should be carried into the boiler. This is guarded against by the high fire test. The oil is therefore spoken of as perfectly harmless.

The Talmage system has become a part of the regular practice of the Erie Railroad, and is being introduced on other roads. It has just been applied to fifty new engines on the Erie, which are of the consolidation type with Wootten fireboxes. Its effect upon the operation of the mechanical department is to place the bad water districts upon very nearly the same basis with regard to boiler washing as those having the best water. It costs about $2.25 to wash out a boiler. This, however, does not compare in importance with the fact that each engine must be held from six to eight hours every time the boiler is washed. The saving of one boiler washing permits an engine to make a trip over a division of 100 miles, and with 47 engines on one of the divisions this advantage amounts to the continuous use of five engines. On one division the boilers required washing out every 500 miles before the oil was applied, and they are now kept in much better condition than before by washing out once in 3,000 miles, and, in some cases, 5,000 miles. In October of last year the system was in use on 49 locomotives, of which 25 were on the Cincinnati Division and 24 on the Lima Division. The cost of application of the system to each engine was not more than $125 in any case, but the cost depends, of course, upon the construction of the boilers. Upon the application of the oil the mileage began at once to increase, the boiler work to decrease and the life of flues to increase. On the Lima Division the engines make an increased mileage averaging 504 miles per engine per month, due to the fact that the boilers are washed out but once in thirty days. The largest mileage between washings in these bad water districts, so far recorded, is 6,000 miles. On the Cincinnati Division the increased mileage between washings has been over ten fold, giving an advantage of 432 miles per engine per month. This resulted in the additional saving in the boiler washing force of two men at Galion and two men at Huntington, the saving at these two points amounting to $192 per month in wages. The average increased life of flues upon engines, of which close record has been kept, has been between 30 and 40 per cent., depending largely upon the service. Engine No. 770 has run for 18 months with one set of flues. The life of flues was formerly 8 months. In the 18 months mileage has been 77,498, and the flues were then taken out for safe ending. The former mileage of flues was between 41,000 and 48,000. Engine No. 780, after making 61,527 miles, required the renewal of only 100 flues, and at the time of the report the rest of the flues had made 78,788 miles and were still in good condition. The increased mileage per engine per month on the Lima Division averaged 504 miles, and on the Cincinnati Division 432 miles. On these divisions the average mileage between washings is 3,500.

The deterioration of the special apparatus of this system is practically negligible. While the average cost per hundred miles on these divisions has been about 30 cents, the increase in the life of flues has been 30 per cent. and of fireboxes 20 per cent., with the engine mileage increased as stated.

In January, 1900, Mr. Mitchell called a meeting of the shopmen, enginemen and motive power officers concerned, and discussed the system thoroughly. The result was its adoption. After an experience of several years, during which the system was in the care of the Talmage Manufacturing Company, circulars of instruction were issued, and the entire operation taken into the hands of the railroad. Because of the importance of the subject and of its development under the personal care of Mr. Mitchell, the circular drawn up by Mr. Talmage, with the assistance of Mr. Mitchell, is reproduced, and it will be seen that a great deal of care is required in the use of the blow-off cocks and in the feeding of the oil. We are indebted to Mr. Mitchell and Mr. Talmage for the information and drawings. The results obtained are in no way sensational, although they are exceedingly important. They testify of the value of following such a subject carefully for a number of years, and the experience of this road is now made available for others. The instructions follow:

To properly carry out the principle of this system, the enginemen should feed the oil regularly and continuously into the boiler when the engine is in service. Specific directions will be furnished to meet the various conditions, as the quantity of oil to be used varies according to the condition of the water and the amount evaporated.

The surface blow-off draws from the entire surface of the water, and will carry off all impurities from that portion of the boiler. It is designed to be used on the road as well as at terminals. Certain waters contain ingredients which, if allowed to accumulate in the boiler, will cause the water to foam. This action is effectually overcome by the use of the surface blow-off. In operating the surface blow-off, the enginemen should be governed by the amount and condition of the water in the boiler, care being taken to avoid the excessive loss of water during this operation.

When the hostlers and engine preparers place the engine on the dump track for blowing, the boiler should have three gauges of water and full pressure of steam. The surface blow-off should be operated first, to reduce the water in the boiler to 2½ gauges. Then each of the other blow-off valves should be operated a uniform length of time, care being taken not to reduce the water in the boiler below one gauge.

Injectors should not be used while blowing off. The blower should not be used until the blowing off of boiler has been completed, and then used to bring steam up to pressure required.

When the boiler washers blow the steam off there should be at least one gauge of water in the boiler, to avoid the heat from drying the flues and sheets.

The crown sheet should be washed immediately after the water has been drawn off from that portion of the boiler, and while the water is being drawn from the lower portion of the boiler.

When the washing is done with cold water the boiler should be properly cooled before drawing the water off.

This system is the result of a patient and painstaking development of principles which have been applied before but always unsuccessfully. They represent a number of years of concentrated effort and study of the conditions of locomotive boiler operation. We understand that this system is protected thoroughly by patents.

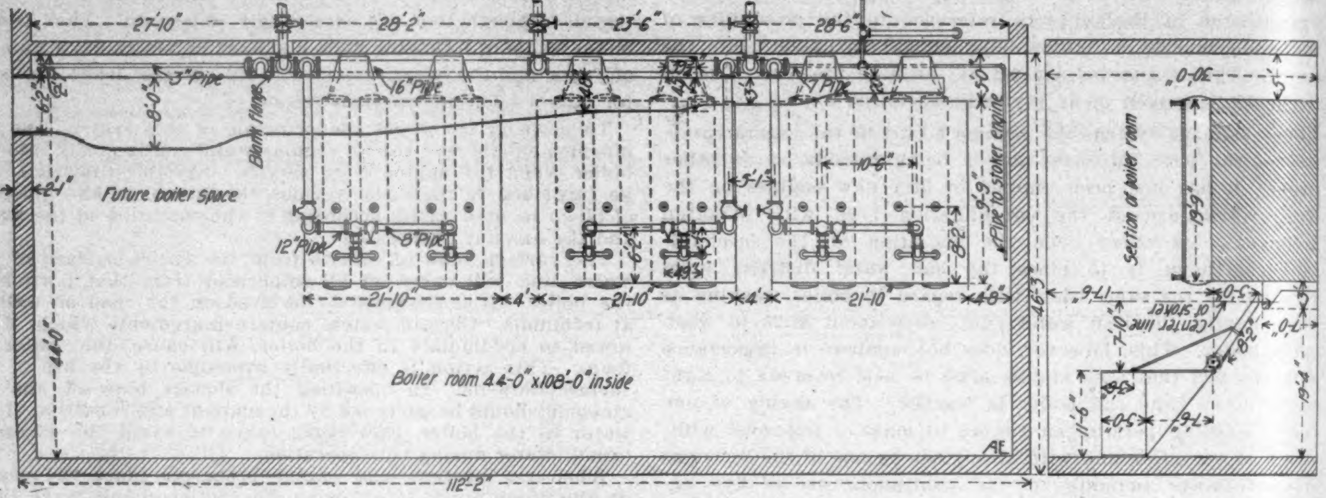
LONG DISTANCE RECORD BREAKING RUN.

Atchison, Topeka & Santa Fe Ry.

We have received from Mr. J. M. Barr, Third Vice-President of the Atchison road, an official report of the recent long distance record breaking run of a special train conveying Mr. A. R. Peacock and party from Los Angeles to Chicago, a distance of 2,236 miles in 58 hours. Mr. Peacock, who is a director of the Carnegie Steel Co., desired to reach Pittsburgh in time for a directors' meeting. The train left Los Angeles at 10 a. m. on Tuesday, March 27, and the contract provided for his arrival in Chicago on Friday morning in time to take the regular Pennsylvania train for Pittsburgh. He arrived in Chicago at 10 p. m. Thursday night, making the run at a speed of 38.55 miles per hour, including stops, and 41.71 miles per hour, excluding stops. The total delays amounted to 4 hours 24 minutes. The train consisted of the special car "Convoy," weighing 105,300 lbs., and a combination car weighing 43,600 lbs., making a total of 148,900 lbs. Ten engines were required for the trip, and it was not until the train reached Albuquerque that any thought of fast running was entertained, and even then there was no attempt at record breaking, and the special train had to get along as it could between the regular traffic trains as no attempt was made to clear the way for it. The

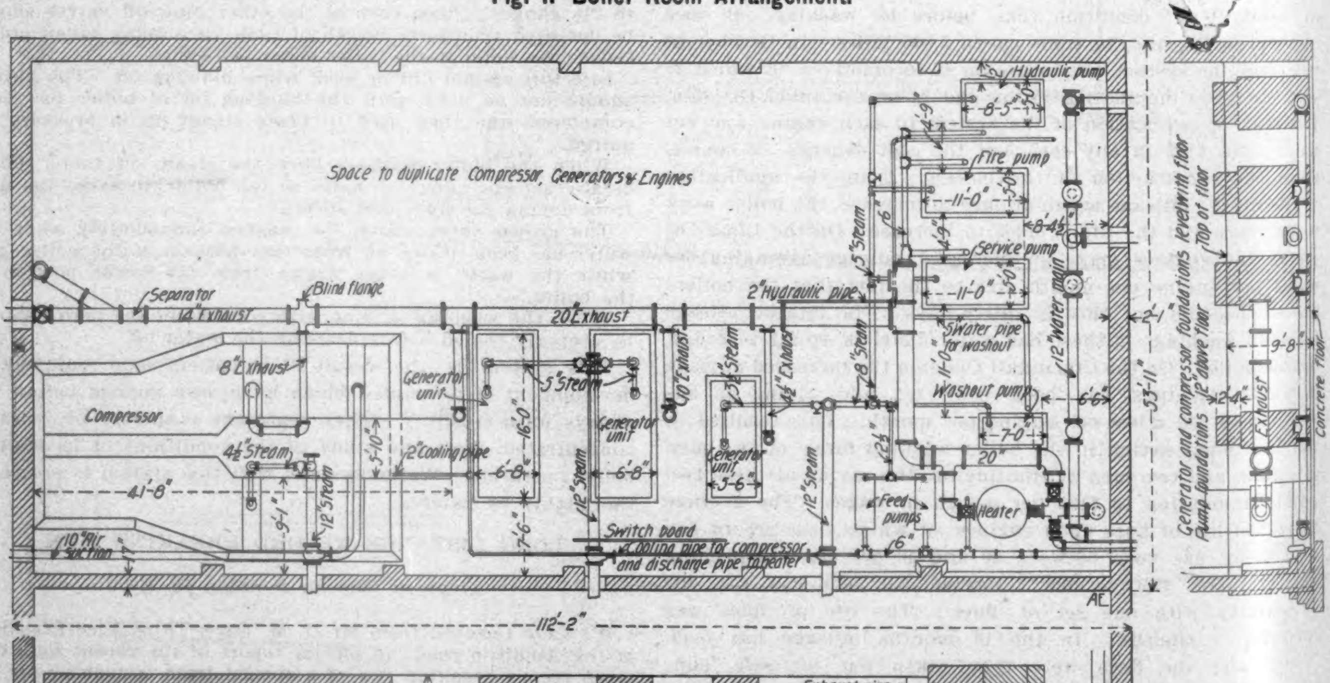
terminals, distances and speeds are given in the following table:

Terminals.	Distance. Miles.	Average speed including stops. Miles.	Average speed deducting stops. Miles.
Los Angeles to Barstow..	141	36.00	37.60
Barstow to Needles......	169	37.55	38.55
Needles to Seligman.......	149	36.19	.....
Seligman to Winslow.....	143	27.67	.....
Winslow to Albuquerque.	286	43.22	.....
Albuquerque to La Junta..	347	31.73	34.57
La Junta to Dodge........	202	55.85	57.12
Dodge to Emporia........	227	52.35	55.90
Emporia to Argentine.....	109	35.41	39.51
Argentine to Chicago.....	463	45.79	49.98
Los Angeles to Chicago..	2,236	38.55	41.71



Improvements, Chicago Shops, C. & N. W. Ry.

Fig. 1.—Boiler Room Arrangement.



Improvements, Chicago Shops, C. & N. W. Ry.

Fig. 3.—Plan of Engine Room, Showing Piping.

This is the fastest run for this distance of which we have record, and it does not by any means indicate the limit for this road. The train made the distance in 12 hours less than the contract called for, and beat the time of the "California Limited" by about eight hours. No instructions were given to make exceptionally fast time, and it was not intended in any sense to be a record breaking train. It is interesting to note that in the 347 miles between Albuquerque and La Junta the train had to climb to a height of 7,492 feet.

CHICAGO & NORTHWESTERN SHOPS AT CHICAGO.

Extensive Improvements.

III.

Power House and Power Distribution.

The general plan of the improvements was given in the March issue, page 92, a description of the buildings in April, page 109, of this journal, and we now present information concerning the power house and power distribution.

Boiler Plant.

The boilers are placed in the north half of the power house. There are six Babcock & Wilcox water tube boilers of 250 h. p. each, arranged with two in each setting, and spare space is provided for two more boilers. The plant now has 1,500 h. p. with room for 2,000. These boilers have vertical headers whereby a

material saving in space is effected. They are equipped with Roney stokers, furnished by Westinghouse, Church, Kerr & Co., and "smokeless" furnaces, which are guaranteed to burn bituminous coal and give full rated capacity with a draft of ⅝ inch air pressure. The arrangement of the boiler room is shown in Fig. 1. On the north side of the building is the track for receiving the coal cars. The coal is unloaded into a hopper below the track from which it is raised by an elevator and deposited into the elevated coal hoppers by means of a horizontal conveyor, the end of which is seen in Fig. 2. The ashes are removed from cars on a depressed track running along the boiler fronts. The coal elevation and conveyor are operated by a 15 h. p. electric motor. There is a 12-in. spout leading from each coal pocket to the corresponding automatic stoker so that all shoveling of coal is avoided after it leaves the car. The boilers carry a pressure of 150 lbs. The arrangement of the piping is seen in Fig. 1. The coal storage capacity is sufficient for 180 tons.

The chimney, which was designed by Mr. G. R. Henderson, is of light colored brick 180 ft. high, including the cast-iron cap. It is lined with firebrick to a height of 75 ft. The core is 8 ft. 6 in. in diameter. The foundation is of concrete laid upon 64

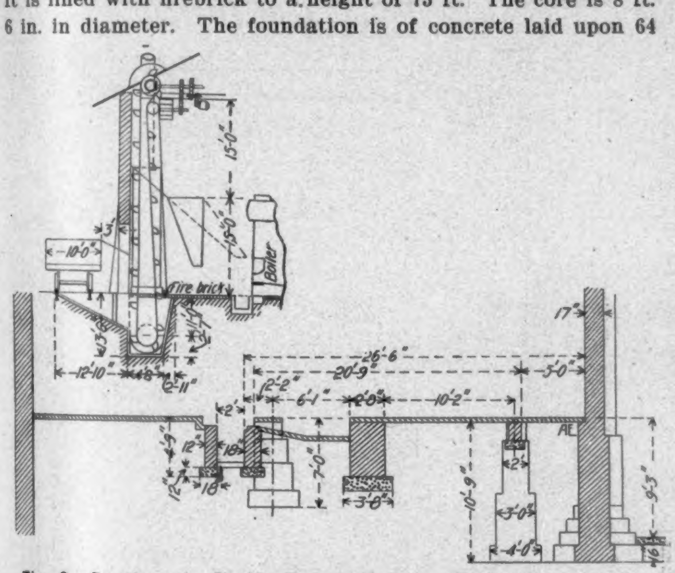


Fig. 2.—Sections in Boiler Room Showing Boiler Foundations and Coal Elevator.

piles. The stack was made large enough to provide for 2,000 h. p., although it will serve at present for but 1,500.

As stated in the preceding article on this subject, from information furnished by the Chicago & Northwestern road, the installation of mechanical draft was taken up in connection with this plant. After carefully considering the design of mechanical draft apparatus with regard to the arrangement of the plant and the necessary height and size of stacks it was decided that three stacks would be required, one for each pair of boilers and that the height should be sufficient to avoid the possibility of sending smoke into the shops, drafting rooms and laboratories, and that the diameters of the stacks should be sufficient for natural draft even when the boilers are forced. This was considered necessary because of the reluctance of the officers of the road to run the risk of a shut-down of one or more boilers by a possible failure of the mechanical draft devices. The depreciation of the smoke fans and steel stacks was placed at about 10 per cent., and all things considered, it was believed that the cost of mechanical draft, if installed under these conditions, would be too close to that of a permanent chimney, which may be expected to last until outgrown without any extensive repairs, to offer any advantages, and at the same time the constant running expense of the fans counted against the mechanical draft. It was estimated that the cost of running the fans would be $340 per year, which capitalized at 6 per cent., would represent $5,600.

Engine Room.

The engine room has two 250 h. p. compound non-condensing engines, driving a pair of 75-kw. generators to which they are direct connected, and a 65 h. p. simple engine direct connected to a pair of 20-kw. generators. The engines were furnished by the Ball Engine Co. They are vertical and arranged with one generator on each side of each engine. This room also contains the Riedler air compressor, feed pumps, fire and service pumps, and a Cookson feed-water heater, which is 112 in. high and 61 in. in diameter, the rating being 1,500 h. p. The pumps are at the right hand end of the room, as seen in Fig. 3. The large engines have 12 and 22 by 14 in. cylinders and run at a speed of 275 revolutions per minute. The small engine has a 9½ by 10 in. cylinder and runs at 360 revolutions. The larger engines are guaranteed to work within 21 lbs. of steam per indicated horse power hour at 150 lbs. boiler pressure, and the small engine to fall below 22½ lbs., the variation in speed to be not more than 2 per cent.

The machinery room is excavated to a depth of nearly 10 ft. and has a concrete floor. The machinery is mounted on foundations located as in Fig. 3, with the air compressor at the left. The plans of this room are exceedingly complete and careful provision has been made for extensions. Space enough remains for the addition of machinery to more than double the present capacity, the open floor space in Fig. 3 being provided for this purpose. The plans cover the steam and exhaust piping for the complete installation so that all possible contingencies have been considered. The exhaust main passes through the center of the building under the floor. It begins with 14 in. pipe and enlarges to 20 in. at the feed water heater. A by-pass is provided at the heater and the steam may be exhausted to the open air or through the steam heating system for the shops. Three 12-in. steam pipes enter the engine room from the boiler room header. These lead to the engines, air compressor and pumps, and they have blank tees for extension to the additional machinery whenever it may be required. The plant may be extended without interfering in the least with the operation of the shops. The piping has swing joints, expansion and contraction being taken up by the threads. Each engine has a separator.

The hydraulic pump in the power house supplies water at a pressure of 1,500 lbs. per square inch, which will be used chiefly for the boiler shop riveters, punches and shears. The accumulator for this pump is located in the boiler shop near the riveter and ingenious mechanism has been devised to start and stop the pump in accordance with the demands made upon the accumulator. This is accomplished by means of a separate pipe conveying pressure from the accumulator to the pump, operating a governing valve at the pump. The distance from the accumulator to the pump is about 500 ft. Soapy water is used in the hydraulic system. The water discharges into an elevated tank, which insures its flow back to the pump for the prevention of pounding and the production of a vacuum in the piping. These pipes are carried overhead, and where they pass between the buildings they will be put into the same casing as the steam pipes.

The water system is served by two underwriters' fire pumps of 1,000 gallons per minute, furnished by Fairbanks, Morse & Co. One of these has a Fisher governor and is intended to maintain a constant pressure of 100 lbs. per square inch. The other pump will be reserved exclusively for fire purposes and will be kept slowly moving at all times. It will be ready to respond instantly upon the opening of the valve. In addition to these there is another pump for washing out locomotive boilers. It is controlled by a Fisher governor and keeps a constant pressure in the washout mains in the round house which will be available day and night.

The air compressor, which is of the Riedler type, was built by Messrs. Fraser & Chalmers of Chicago. It has air cylinders 16 and 27 by 36 in. and steam cylinders 16 and 28 by 36 in. Its capacity is 1,500 cubic feet of free air per minute compressed to 90 lbs. per square inch, and the speed is 65 revolutions per minute, the steam pressure being 150 lbs.

The air cylinders are equipped with Fraser & Chalmers'

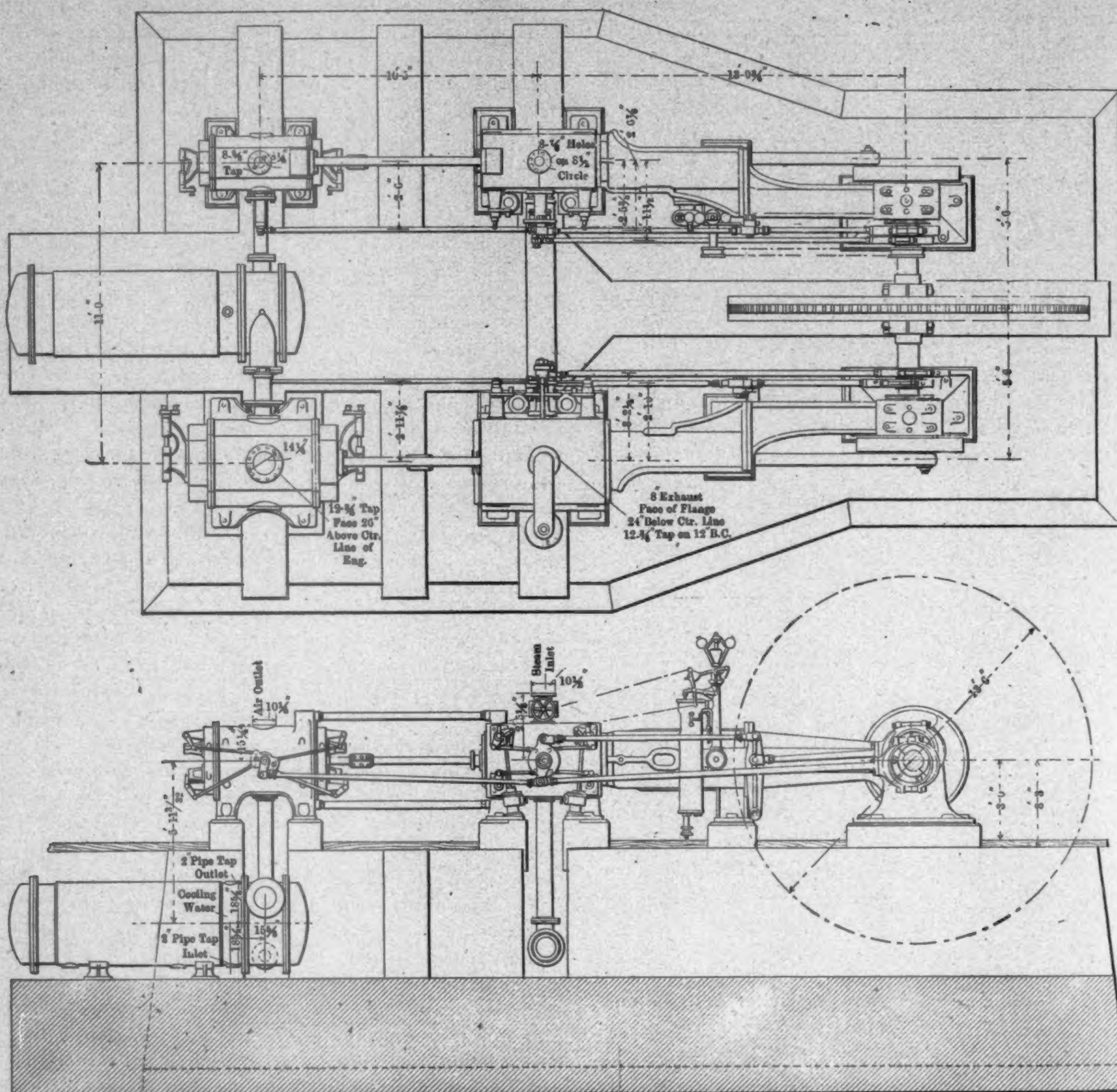
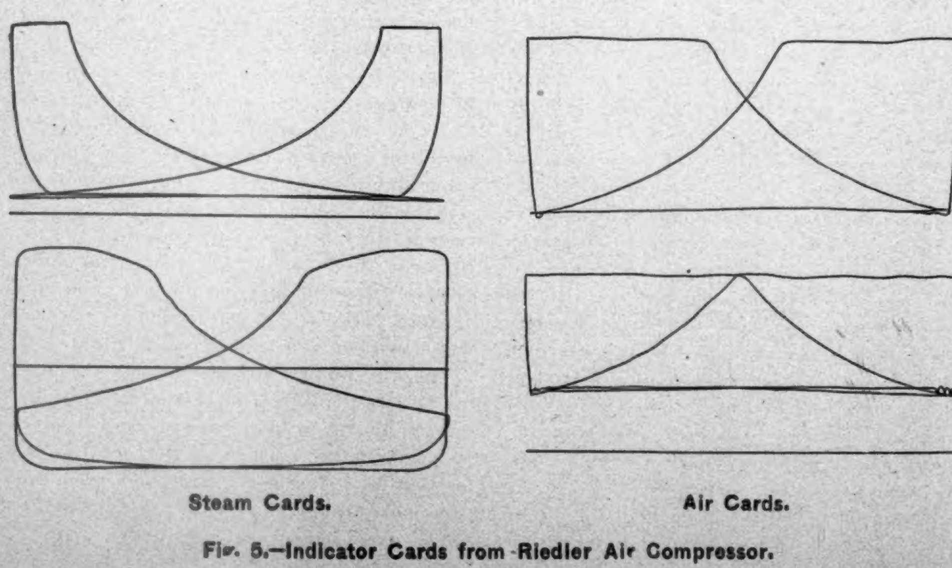


Fig. 4.—Riedler Air Compressor, Built by Fraser & Chalmers, Chicago.



Steam Cards. Air Cards.

Fig. 5.—Indicator Cards from Riedler Air Compressor.

improved form of Riedler positively controlled air valves, the valves being made of forged steel and so arranged as to be easily adjusted when the compressor is in operation. Between the high and low pressure air cylinders is placed an intercooler having 375 sq. ft. of tube cooling surface. The engines are of Fraser & Chalmers' standard Corliss type with steam jacketed cylinders. The speed of the compressor is regulated by a combined steam and air governor, this being so designed that the speed of the compressor is varied to meet the demands for air, the steam governor coming into action only in case the engine speed should increase beyond the maximum desired. To allow the compressor to run at slow speed when but little air is being used, an extra heavy flywheel is provided on the crank shaft. The steam consumption of this compressor, when running at its normal speed, compound, noncondensing, with the steam pressure at the throttle of 150 lbs. per sq. in., and delivering air under a pressure of 100 lbs. per sq. in., will not exceed 58 lbs. of dry steam per 1,000 cu. ft. of free air compressed. Actual air cards taken from a similar type of Riedler air compressors are reproduced in Fig. 5. These cards may be compared with those generally obtained from ordinary makes of air compressors, to show the effect of the Riedler positive valve mechanism. The lost work with the latter mechnism, as shown by the cards, is reduced to the very minimum.

The cooling water for the compressor is returned to the feedwater heater for use in feeding the boilers.

The generators, of which there are six, were all furnished by the General Electric Co., and they are all standard machines. The four larger ones are 6-pole, 75-kw. machines, furnishing 600 amperes at 125 volts. The others, driven by the small engines are 25 kw., furnishing 160 amperes at 125 volts. The generators are connected with a marble switchboard of 8 panels. The light switches are on triple bus bars and the power switches on double bars with 220 volts difference in potential. The lights and motors are on separate circuits, but the switchboard is arranged so that one pair of generators may operate motors or lights or any number of the generators may be operated in parallel through bars and equalizer ties on the switchboard.

The whole area of the engine room may be reached by a hand-power overhead traveling crane of 7 tons capacity, with a span of 49 ft. 3 in., and a travel of 22 ft. 9 in. of the hook.

Power Distribution.

The power required to drive the shops was estimated from indicator diagrams taken from the former steam engines, with proper allowances for the increase in the machinery.

The machine shop, which was formerly driven by a steam engine of about 100 h. p., has four 35 h. p. motors located at different points. Each motor drives an independent section of the main shafting and operates the tools in its vicinity. The shafting in this shop has been in use for a number of years and the tools were grouped in accordance with convenience and economical operation of the shop. It was not considered advisable to disturb the arrangement.

The machine shop annex (see plan, Fig. 8, page 111), has four 20 h. p. motors which were formerly used as generators. These run at 110 volts and each drives a section of shafting 150 ft. long. Two of the motors are placed on the first and two on the second floor. There are 8 motors for running the machine shop, including the annex, and a 10-h. p. motor operates a walking crane in the main machine shop, which runs the entire length of the building. The motors are placed on foundations in the floor and connect directly to the shafting by belts. The machine shop, as originally constructed, did not provide for overhead crane service over the locomotives, except for the lighter parts, and in the original construction of the shops the machinery was belted in such a way as to be out of the way of the light hand cranes over the engines. Eventually this shop will probably be rebuilt and cranes of large capacity will then be installed, but this is not contemplated in the present plans.

The boiler shop has a 20 h. p. motor for the smaller machinery and a set of 14 ft. bending rolls is driven by a 25 h. p. individual reversing motor which operates the rolls and the feed. There are two electric cranes in this shop. The larger one of 50 tons has three motors of 10, 7½ and 5 h. p., while the small one of 5 tons capacity has three of 9½, 5¼ and 1¼ h. p. The transfer table, which serves the machine and boiler shop, has been operated by a 10 h. p. motor. When this table is lengthened and remodeled it will be operated by a 20 h. p. motor.

The tank shop has one 25 h. p. motor for running the machinery, including a wheel lathe, drill press and wheel boring machine. The completed tender work is provided for in this shop. In addition to these there are two 5 h. p. individual motors for a punch and shear. This shop has a 30-ton crane.

Additional power is provided at the two round houses where the turn tables are operated by 10 h. p. motors acting with direct adhesion; at the paint mill, where grinding machinery is operated by a 95 h. p. motor and at the blacksmith shop where a 35 h. p. motor drives fans, bulldozers and bolt machinery.

All of the motors, except those in the machine shop annex, which were formerly used as generators, operate under 220 volt direct currents and the lighting circuits carry 110 volts, including those for the 100-hour enclosed arc lamps. The current is taken to the motors through heavy weatherproof cables carried overhead. The lights are all on three wire circuits. The power circuits are arranged as follows: One three-wire circuit for the 110- volt motors in the machine shop annex; one two-wire circuit for the blacksmith, carpenter and tank shops; one two-wire circuit for the machine shop, one for the coal conveyor in the boiler house; one for the paint shop motor; one for the cranes in the boiler and tank shops; one for the two car shop transfer tables; one for the round house turntables and one for the locomotive transfer table.

This work involved a large number of difficulties. It is not offered as a model establishment, but as an excellent example of the application of electrical distribution in extending an old plant. One fact which stands out boldly in an examination of this problem is the necessity for providing for improvements and extensions in the original construction of shops. Another is the great importance of crane service and providing for convenient handling of work and material.

Mr. Robert Quayle, Superintendent of Motive Power of the road, has been exceptionally fortunate in having the assistance, first of Mr. W. H. Marshall, now Superintendent of Motive Power of the Lake Shore, and afterward that of Mr. G. R. Henderson, in the planning and execution of this work, and that of Mr. F. M. Whyte, now Mechanical Engineer of the New York Central, and his successor, Mr. E. B. Thompson.

Mr. Sidney H. Wheelhouse, formerly Sales Agent for the Chicago Pneumatic Tool Co., has been appointed Second Vice-President of the Standard Railway Equipment Co., in charge of the pneumatic tools sales department, for the west, with offices at 412-414 Lincoln Trust Building, St. Louis, effective May 1st, 1900.

A remarkable trip of an ice breaking steamer on Lake Baikai, Siberia, is recorded by "Engineering News" as having been made February 10. The distance of 80 miles through ice 31 inches thick was made in 12 hours.

The Lehigh Valley Railroad has ordered three locomotives from the Baldwin Locomotive Works for its "Black Diamond Express." These will be somewhat larger than the engines which are now handling this train. They will have 20 by 26-inch cylinders, 80-inch drivers, 200 pounds boiler pressure, 108 by 90-inch fireboxes, 326 2-inch tubes, 15 feet 6 inches long, 4,500 gallons tank capacity, and they will weigh 157,000 pounds each, of which 90,000 pounds will be on the drivers. The wheel base is increased by the large drivers, but otherwise the locomotives will be the same as the present engines.

(Established 1832)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

J. S. BONSALL, Business Manager.

MORSE BUILDING..NEW YORK

G. M. BASFORD, Editor.

E. E. SILK, Associate Editor

MAY, 1900.

Subscription.—$2.00 *a year for the United States and Canada;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union.*

Remit by Express Money Order, Draft or Post-Office Order.

Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

Damrell & Upham, 283 Washington St., Boston, Mass.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* American Engineer and Railroad Journal *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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Sir William Preece recently defined mathematics as the shorthand of thought and the purest form of logic; experiment as the handmaid of observation; and measurement as the instigator of accuracy and precision. He is thus quoted in "Engineering" and in these few words has framed a pure ideal of technical education.

Methods of handling scrap material from car and locomotive shops have been greatly improved during the past few years, and a great deal has been done to increase the value of reclaimed material. On many large roads there is room for further improvement, one suggestion being in the direction of managing the scrap on a wholesale or manufacturing basis. In large plants, including both car and locomotive shops, the scrap is generally cut up and handled in several places. There seems to be a decided advantage in taking all the scrap material to one place which is provided with tools necessary for cutting it up and with facilities for storing the good material in usable form, the object being to concentrate this material to such an extent as to permit of issuing it in carload or half-car load lots, and placing prices upon it. The mere fact of the price being a possibility places this work upon a manufacturing basis than which there is no more important element tending in the direction of businesslike management of shop matters.

The usual attachment of tender tanks to the frames by means of bolts at each of the four corners was never secure or satisfactory, and it is much less so with the great increase in capacity whereby from 6,000 to 7,000 gallons of water and 10 to 12 tons of coal are carried. Something is needed to prevent the tank from sliding forward and crushing into the cab as a result of collisions. With the newer forms of tanks there is no difficulty in placing a substantial member of the frame in such a position as to hold the tank securely against such movements.

Experiments recently made with a locomotive with a wide firebox have shown very nicely that the grate area which is suitable for one quality of coal may be entirely wrong for a different quality. An engine with a grate area of 70 square feet when used in fast passenger service was taxed so nearly up to the limit of its boiler capacity that the entire grate area was needed even with the best of coal, which was anthracite. When running in less exacting service the grate was blocked off at the front end so as to shorten it one and one-half feet, with excellent results with the same coal as before. When an inferior grade of coal was tried on the slower and lighter trains the whole grate was needed again. This shows, conclusively, the advantage of building grates which are larger than are required for the best coal and comfortable conditions in order to provide for more exacting trains and less effective fuel. Adjustability of grate area seems to be desirable for the same reason that recommends adjustable cut-off, to meet varying requirements of work to be done.

That the comparison of operating statistics of different roads working under widely different conditions is very misleading and unfair is generally understood by motive power officers. It is not so well understood by other officials, however, for presidents and general managers not infrequently cause their motive power superintendents a great deal of trouble in trying to show why they do not make as good records as their neighbors and others. Comparisons would be of the greatest value if they could be made with intelligence and fairness, but methods now in use are not satisfactory. The train-mile is not fair because it gives no idea of the work done. The ton-mile basis is better, but unless the grades and speeds are known even this cannot be used to compare different roads. Not only the speeds and grades, but also the character of the locomotives, the location of water stations, character of the water and general climatic conditions affect the results. Furthermore, the methods of different roads in computing train mileage are by no means the same. It may or may not include the mileage of double headers, light engines, switching, pushing and work train engines. It may or may not include the weight of the engine in the tonnage. In spite of these difficulties the fact remains that comparisons will be made. It is therefore important that all roads should agree upon uniform methods of reporting statistics. The Western Railway Club did wisely to send a copy of the proceedings of its recent meeting, in which this question was the subject of discussion, to the Association of Railway Accounting Officers and the American Railway Association committee on statistical information. This is a much more serious question than it at first appears. We know of a case where the head of an important department and several of his assistants were changed chiefly because locomotive repairs were not reduced from four to three cents per mile, as required by the new management. This arbitrary figure was fixed because it had been attained on the road from which the new management had come. It was developed afterward that the higher cost of repairs on this road was accompanied by correspondingly greater ton mileage. Whatever else is accomplished, the train or engine mile basis for statistics in comparing the work of different roads will be discarded when its misleading character is understood.

GOOD FIRING IS THE BEST SMOKE PREVENTER.

Satisfactory methods of burning soft coal without smoke have been sought for for over a hundred years. We say satisfactory because it has been repeatedly demonstrated that smokeless consumption can be accomplished, but when special devices are employed there is likely to be some mechanical defect which is troublesome, if not fatal.

A valuable contribution to the literature of the subject is the recent report of a committee of the Western Railway Club, Mr. G. R. Henderson, Chairman, which was appointed to consider what is being done toward improvement in this respect on locomotives in Chicago, and to indicate, from a careful study of various methods, the probable best direction for future development. The various mechanical devices investigated by the committee were sometimes heartily endorsed, sometimes equally strongly condemned by those who have used them. It is clear that these are not considered promising in the ultimate solution of the problem. Wider fireboxes are looked upon with hopefulness, but "only certain types of engines permit of this arrangement, and its use is limited."

The composition of coal has much to do with this question. Those high in fixed carbon and low in volatiles, like the Pocahontas of Southwestern Virginia, produce very little smoke. This coal contains from 75 to 80 per cent. of volatile matter, but Illinois coals, with about half as much fixed carbon and twice as much volatile matter, represent the real problem. It is not made easier by the fact that many roads are obliged to use a large number of coals which require different treatment in accordance with their composition. One road running into Chicago draws its supply from more than 100 mines, and at times it is necessary to get along with very inferior fuel. This indicates the necessity for flexibility in any system in order to adapt it to various conditions.

This committee gives special prominence to the skill of the fireman and to co-operation between the engineer and fireman. The best results in smokeless firing are obtained on a road which uses no devices whatever except the brick arch. While air compression above the fire is held by some to be effective, it is generally considered as a smoke diluter rather than a consumer. There is strong support for the practice of drawing the air needed for combustion through the fire instead of introducing some of the air over it and making use of the brick arch for mixing the gases and forming a combustion chamber.

There is, apparently, nothing so effective in smoke prevention as skillful firing, and the general opinion seems to be that a good fireman can accomplish more without special devices of any kind than an indifferent fireman with them. It is necessary for the engineer and fireman to understand each other. The fireman should be informed in advance of every change which the engineer is to make, so that the fire may be kept in readiness for the changes. There is a good field for expert or "traveling firemen" in the education of the men. The practice of firing five or six scoopfuls at a time and resting between, should give place to light and frequent firing, the door being left open a little on the latch to admit air enough to burn the fresh distillates, and then closed, unless a damper is provided in the door. If a stop is to be made when green coal is on the fire, the blower should be applied before the steam is shut off, and as soon as the throttle is closed the door should be opened slightly on the latch and the blast of the blower reduced sufficiently to prevent black smoke and to keep the pops from blowing.

This report states in effect that there is no panacea for smoke; that the necessary treatment varies with the quality and composition of the coal; that the matter is largely in the hands of the fireman and engineer, and that the firing should be done in such a way as to avoid chilling the surface of the fire by excessive increments of fuel, the method of adding fuel being to scatter it in thin layers and admit sufficient air to consume the hydrocarbons which are distilled off in large volume as soon as the fresh coal drops upon the hot fire.

The superimposed turrets of the new battleship "Kearsarge" have been put through firing tests which are reported to have been satisfactorily met. The advantages of the construction are a heavy concentration of fire, good protection for the ammunition hoists for the 8-inch guns of the upper turrets, and a great saving in weight. There is also no interference in the gun fire. The trial tests showed that the mechanism worked well, but nothing but a trial in actual battle can show the effect of gun fire upon the turrets. A single successful shot may disable two 12-inch and two 8-inch guns.

The annual report of the Commissioner of Patents shows a surplus of $113,673 for the operations of the year 1899. The total balance to the credit of the Patent Office at the beginning of this year was $5,086,649. It is well known that the present quarters are too small and that a fireproof building for the records is greatly needed. The fact that the office is self-supporting is a good reason for supplying these deficiencies, entirely aside from the great value of the records. The total number of applications for 1899 was 41,443 and present indications point to a breaking of the record for the current year. The commissioners appointed by Congress to revise the laws relative to patents have submitted a preliminary report and will soon present a complete report. At that time Congress should be urged to act for the improvement of the Patent Office and the revision of the statutes relating to trade marks.

The idea of lectures delivered by the best non-resident engineers and men of authority that the country affords, to engineering students, is one of which many of our technical schools and colleges are availing themselves. The following schedule for the year 1899-1900 has been sent us by the University of Illinois, six lectures of which have already been delivered: Mr. Walter B. Snow of the B. F. Sturtevant Company, Boston, Mass., on "Mechanical Ventilation and Heating." Mr. H. G. Prout, editor of the "Railroad Gazette," on "Engineers and the Railroads." Mr. A. V. Abbott, Chief Engineer of the Chicago Telephone Company, on "Electrical Highways." Mr. F. W. Willcox of the General Electric Company, Harrison, N. J., on "The Evolution and Economic Use of Incandescent Lamps." Mr. F. H. Newell, Hydrographer, United States Geological Survey, Washington, D. C., on "Hydrographic Work of the United States Geological Survey," and on "Reservoir Surveys Along the Gila River, Arizona." Mr. W. A. Layman of the Wagner Electric Manufacturing Company, St. Louis, Mo., on "Transformers in Modern Electric Power Transmission." Prof. R. B. Owens, McGill University, Montreal, Canada, on "Most Recent Developments in the Applications of Electricity."

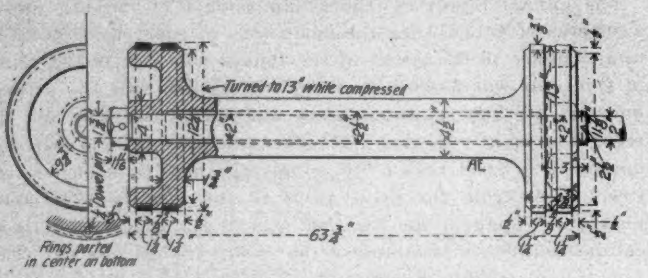
The Massachusetts Institute of Technology has at present two holders of traveling fellowships studying architecture in Europe. Mr. H. W. Gardner, an instructor in the department of architecture, is to pass a year mainly in Italy and Greece. In Italy he is giving much study to its landscape architecture, in preparation for the part he is to take on his return in the courses of Landscape Architecture already so well started at the Institute. Mr. G. P. Stevens, holder of the other fellowship, after traveling and working with Mr. Gardner, is now in Pascal's atelier in Paris, preparing to enter the Ecole des Beaux Arts at the next examination. Mr. Stevens' skill in draftsmanship at once brought him into notice, and he writes of his good fortune in being chosen by the strongest man in the atelier, and one of the strongest men in Paris, to help him in a Beaux Arts competition for which only five men were invited. The competition is to use the grounds now occupied by the Exposition buildings after the fair is over, for a huge system of public baths.

The United States will stand at the head of the coal producing countries of the world at the end of the current year if the estimated output of this year is realized. In the past 30 years Great Britain has not doubled her output, while that of the United States has increased almost seven fold in this time.

PERFORMANCE OF THE CLEVELAND LOCOMOTIVE.

Intercolonial Railway.

A system of dual exhaust applied by Mr. L. J. Todd in England was illustrated and described in our issue of September, 1897, page 311, because of its interest as a suggestion for overcoming some of the cylinder condensation in locomotives due to the use of the same passage for the entrance and exit of steam used in the cylinders. An experiment in the same direction



Piston Valve—Cleveland Cylinder.

has been tried on the Intercolonial Railway of Canada with the Cleveland arrangement of cylinders which have been in use on that road for the past nine months and a record of which we now present, showing the performance of the engine when compared with other engines on the same road running in similar service. The record is not stated in ton miles, but we are assured that the service is comparable.

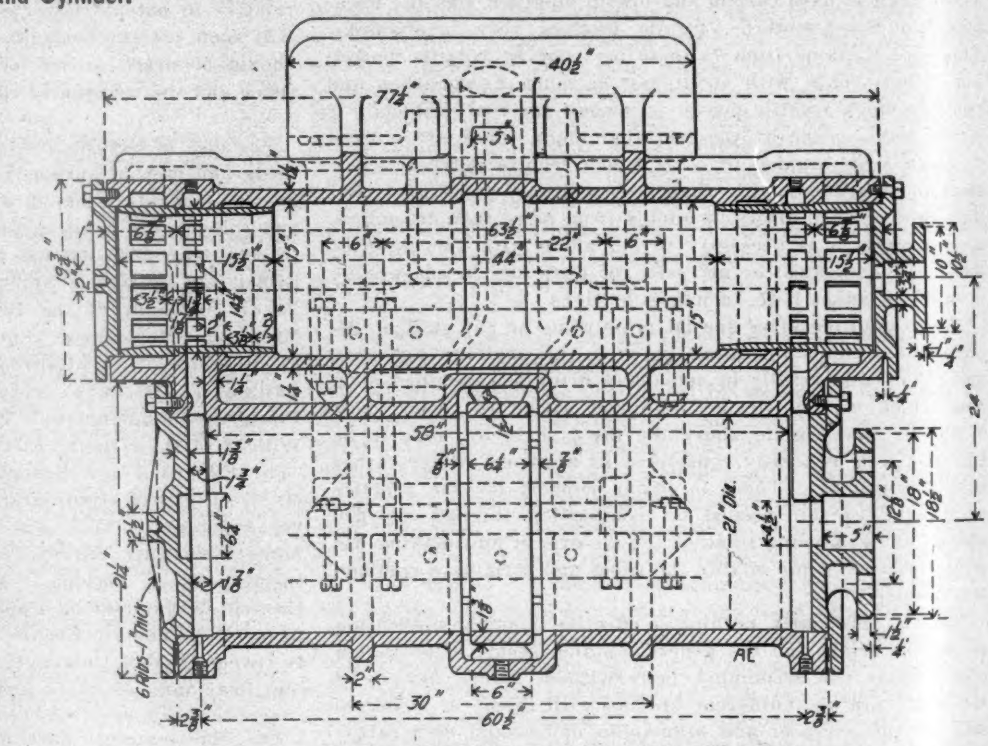
The Cleveland engine, No. 288, has cylinders 21 in. diam. x 28 in. stroke and 56 in. driving wheels, and is one of a lot of twenty consolidation engines built by the Baldwin Locomotive Works for the I. C. R.; the other nineteen engines being fitted with Vauclain compound cylinders, 15½ and 26 by 28 in. and the same size driving wheels. The proportions of cylinder power of the Cleveland and Vauclain engines were computed by the builders to be equal. The steam pressure in both types and the weight on he drivers is the same in all cases, viz., 147,000 lbs., but the Cleveland engine has 21,900 lbs. on the truck which is 4,600 lbs. more than the compounds.

Comparative statement of the performance and consumption of coal, of the compound consolidation, Cleveland consolidation and 10-wheel freight locomotives, for the months of October and November, 1899:

October, 1899.	19 Compounds.	Cleveland. Locomotive.	12, 10-Wheel Freight Locomotives.
Train miles....................	51,243	2,202	22,406
Engine miles..................	59,010	2,662	29.405
Car miles	1,432,470	64,833	424,269
Tons coal consumed.........	2,665	121	1.138
Average cars per train.....	27.95	29.44	18.94
Av'ge lbs. coal eng.-mile...	101.16	101.82	86.69
Av'ge lbs. coal car-mile....	3.62	3.46	4.58
November, 1899.			
Train miles....................	56,128	2,069	26.742
Engine miles..................	64,167	2,257	33.249
Car miles	1,490,370	55,131	488.592
Tons coal consumed........	3,119	111	1,440
Average cars per train......	26.55	23.65	18.28
Av'ge lbs. coal eng.-mile...	108.88	110.16	97.01
Av'ge lbs. coal car-mile....	4.10	4.13	5.31

A tabulated statement sent us by Mr. Cleveland, given above, shows the totals and averages of the performance of 19 Vauclain, 12 10-wheel freight engines with 18 x 24 cylinders and 57 in. drivers, and engine No. 228, consolidation fitted with the Cleveland cylinder, for the months of October and November, 1899, during which time the several engines were hauling practically the same class of freight, under conditions not specially favorable to the Cleveland. It will be noted that the coal consumption for the Vauclain and Cleveland engines is practically the same, both being considerably below the ordinary simple engine and all of the engines were in good condition. A statement given in the accompanying table shows the results of a test made for speed with a full load, going up grades varying from 0.89 per cent. to 1 per cent. From the sectional views of the cylinder piston and valve there will be no difficulty in understanding the main points of deviation from the ordinary simple locomotive cylinder. It will be noticed that there are two annular ports running round the barrel of cylinder, 6¼ in. apart, dividing at the central vertical line.

The piston passes these ports alternately, releasing the steam after it has done its work, and exhausting between the two discs of the piston through an exhaust independent of the supplementary or ordinary valve exhaust. The admission, or ordinary valve, is of the piston type, taking the live steam from

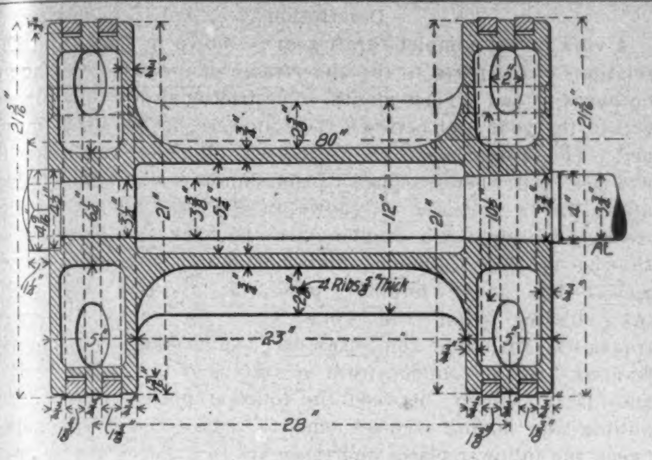


The Cleveland Cylinder and Piston Valve Chamber.

the intermediate space between the two valve discs. The valve serves for an entirely independent adjustment of admission of steam irrespective of the main exhaust, and regulates the compression of what steam may be left on the return stroke.

The release of steam through each piston exhaust and valve exhaust is separate and independent until it gets to the upper part of the exhaust pipe; the piston exhausts combine, in the central chamber, and are supposed to act as a draw or induction on the valve exhaust, the valve exhaust issuing from the annular space. The space between the two discs forming the cylinder piston is filled with steam at a temperature nearly equal to that of the initial exhaust, and this is believed to keep the walls of the cylinder in a more favorable condition than is the case in the ordinary cylinder.

The Cleveland cylinders apparently enable the engine to work very smoothly and they avoid the excessive cushioning found in high-speed locomotives. That this is so has been proven in engine No. 228, which has been running an express train, the "Maritime Express," on scheduled time for the last two months, making 156 miles on a double trip daily, and has at times made up in time as much as 25 minutes on



Piston of the Cleveland Cylinder.

the single run of 78 miles, and this with everything working perfectly cool. This performance for a consolidation engine with 56-inch drivers is exacting, and speaks well for the free running qualities of the engine. The schedule for the 78 miles is 2 hours 18 minutes.

It is claimed for this system of single-expansion engine that there is a direct saving in quantity of steam used at a given pressure to do a given amount of work. This, of course, means less coal consumption and other advantages, owing principally to the rapid exhaust keeping the temperature above that of ordinary single-expansion engines, thus allowing a greater range of expansion, and at the same time this rapid exhaust very materially reduces the back pressure. This, of course, is a direct gain. The clearance is much less than in the ordinary cylinder, and taking into consideration that the greater the expansion the greater the loss by clearance, one can easily understand how this cylinder can compete with the compound system. Also as the great bulk of the exhaust steam passes

Test for Running Time, Made November 2, 1899.—Weight of Train, Cars only 1,234 Tons; Number of Cars, 38. Baldwin Compound, $\frac{15\frac{1}{2}\text{ in.}}{26\text{ in.}}$ × 28 in. Cleveland Simple, 21 in. × 28.

Name of Place.	Engine No. 215. Time of Day.	Time in Minutes.	Totals of Times.	Water.	Engine No. 228. Time of Day.	Time in Minutes.	Totals of Times.	Water.
Started from Moncton	11:52½			Water used, in gallons, for total running time, 1,920 gallons.	13:33½			Water used, in gallons, for total running time, 1,655 gallons.
1st mile post........	12:08½	13			13:39	5½		
2d " "	12:12½	4			13:42½	3½		
3d " "	12:15½	3			13:45	2½		
4th " "	12:18¼	2¾			13:48	3		
5th " "	12:23	4¾			13:52¼	4¼		
6th " "	12:27½	4½			13:57	4¼		
7th " "	12:30	2½	34½		13:59¼	2¼	25¾	
Stopped Berry's Mill...............	12:31½				14:00½			
Started from Berry's Mill	12:34				14:30			
1st mile post........	12:38	4			14:33	3		
2d " "	12:46	8			14:38½	5½		
½ mile to top hill...	12:50	4	16		14:41¼	2¾	11¼	
Total running time.			50½ min'ts.		Total running time		37 minutes.	

Note.—Waste of water due to using injectors not taken into account.

through independent passages, the live steam entering through short passages has a good chance to do its initial work without being cooled on its way.

The cylinder is designed to have a perfect drainage, and on referring to the section of the cylinder it will be found that there are no pockets for the accumulation of water. This is a point of importance lost sight of in most cylinder designs.

In this record it must be considered that the Cleveland engine is compared with the average of 19 compounds. There seems to be good reason for believing this engine is superior to an ordinary simple engine and it deserves further trial.

PNEUMATIC TOOLS BEFORE THE INSTITUTION OF MECHANICAL ENGINEERS, ENGLAND.

The meeting of the Institution of Mechanical Engineers just past was devoted to the discussion of Pneumatic Tools and Power Hammers. The speeches were made by the following gentlemen:

Mr. Simpson, of Pimlico; Mr. Ivatt, Locomotive Superintendent of the Great Northern Ry at Doncaster; Mr. John Fielding, of Gloucester; Mr. B. Martell, of Lloyd's Registry of Shipping; Mr. Marriner, Mr. Alfred Hanson, of Messrs, Shone & Ault, and Mr. J. W. Duntley, President of the New Taite-Howard Pneumatic Tool Company of London, and also President of the Chicago Pneumatic Tool Company of Chicago.

Mr. Duntley, in his remarks, said that he had been making pneumatic tools for five years past. Perhaps it would give the best idea of popularity in the United States if he stated their output. During the first year they were in business they made 100 machines, all told. Last year they averaged 800 per month. At the present time they were building new works, and expected to double their production. By aid of these tools, Messrs. Cramp, of Philadelphia, had been able to overcome the results of a strike of 7,000 men, and in one ship they had just built all the rivets were closed by pneumatic machinery; as a consequence, Messrs. Cramp had given a duplicate order for the pneumatic machines. A proof of the superiority of pneumatic riveting was given in the fact that the rivets themselves were ⅛ inch longer than for hand riveting, and this additional metal had to be closed into the holes, thus showing that the latter were better filled by the use of the pneumatic riveter than by the hand hammer. Another proof was given in the cutting up of work. With ordinary hand riveting, if the heads of the rivets were cut off, the shank would fall out from the holes in the plates, but when the rivets had been closed by the pneumatic machine they had to be driven out.

The speaker himself was not a skilled operator, but in a contest in Germany he had beaten the hydraulic riveter; ninety-seven per cent. of the railroads in the United States were using these tools, and the speaker gave a large number of instances in which air machines were used for superseding hand work. In the United States Government shipyards they used the pneumatic hammer for scaling ships, and it was found to be a great improvement on the old method. Another use for pneumatic machinery was in breaking up iron or steel vessels. They had what was called a "biter" or "nibbler," which chewed off the heads of the rivets in place of cutting them by chisel and hammer. New uses were constantly being found for compressed air; in chipping stone work there had been found to be a saving of $9.00 a day, a rimer did the work of 22 men, and lately he had seen a freight car painted by compressed air in seven minutes. In this country we were in a position to appreciate what had already been done in America in the introduction of compressed air machinery. It was not always easy to get a new thing introduced, and it might be interesting to state that he had worked two years with Cramp's before he could persuade them to give him an order.

Mr. Churchward, of Swindon, said he would like to ask Mr. Duntley a question as to the stay-bolt biter. They had had one at Swindon for some time, but could not get it to work; the claw would not take hold for some reason. Mr. Duntley, in his reply, said that the action of this machine depended on the shape of the claws, and this, again, depended on the nature of the work to be done. The claw must be so arranged as to bite in. Mr. Duntley further stated that he was about to proceed to Russia to arrange for a large installation of pneumatic machinery in that country, and on his return he would be pleased to go down to Swindon and put the machine right. Mr. Churchward further remarked that he did not wish it to be understood that he made any complaint, as the pneumatic machines did their work well, and whatever repairs might be needed were well paid for in the total result.

It is officially announced that on Saturday, April 28, 1900, the office of Purchasing Agent of the Lehigh Valley will be moved to the Taylor Building, 39 Cortlandt Street, New York, also the office of Chief Engineer will be moved to the Havemeyer Building, 26 Cortlandt Street, New York.

Mr. Charles E. Rettew, Master Mechanic of the Pennsylvania division of the Delaware & Hudson, has resigned, after 15 years' service.

THE WESTINGHOUSE FRICTION DRAFT GEAR.

The Construction and Operation in Detail.

The very rapid development of cars of large capacity and the great increase in power of locomotives have left the ordinary forms of draft gear far behind and heavy trains are frequently hauled with the draft gears on a large number of the cars stretched out so that the springs are solid, the spring capacity being entirely exhausted. The train then resembles a chain with practically no elasticity except that of the structures of the cars themselves.

The strains that the couplers, draft rigging and car framing are subjected to when this condition prevails cannot be measured, and are only limited by the elasticity and yielding character of the structure of the car and its draft attachments. While cars were light and all built of wood (a very yielding material) the strains imposed were tolerable, and by good design, care in the selection of materials and good construction, durable cars were obtained. The advent of the heavy steel car has radically changed the amount of elasticity obtainable and, consequently, enormously increased the strains upon draft rigging, without considering the further increase due to larger and heavier locomotives. It is difficult to get room for sufficient spring capacity to overcome this difficulty, nor is it desirable to do so, for any increase in spring capacity alone is unavoidably accompanied by a corresponding increase in recoil, the effect of which is more severe upon the draft rigging than the direct stresses with the lighter springs would be. If the result upon the draft rigging, when a train with ordinary draft springs is forcibly bunched, as in passing through a sag, is considered, it will be seen that the amount of force put into such springs, in the compression produced by the cars running together or "bunching," is practically all given out again in recoil as the train is stretched; furthermore, the amount of such recoil is added to the strain imposed upon the draft rigging by the locomotive. It is well known that under exactly such and similar conditions are trains most often parted when fitted with the ordinary draft-spring capacity and locomotive power. How disastrous will be the results of largely increasing the ordinary draft-spring capacity in addition to the employment of more powerful locomotives, can only be conjectured, but that it will necessarily be great cannot be doubted. The purpose of the Westinghouse draft gear is to furnish a moderate spring capacity and a gradually applied and automatically released resistance, capable of absorbing all of the stresses and shocks likely to be imposed upon it, in either pulling or buffing, and to apply this resistance without a damaging recoil, the recoil being only that due to a free spring capacity much less than that now in general use, while the resistance to pulling and buffing stresses of this form of draft gear is over six times as great as that ordinarily used. To make the operation of the device clear requires an exhaustive description, but the device itself and the great importance of improved draft gear justify it.

Description.

A view of the complete draft gear is shown in Fig. 1 and the relations of the parts to the underframe of the car were shown on pages 88 and 89, last month. The frictional device is placed within the yoke and between the followers, in the usual manner. To accommodate the increased diameter the yoke is widened, and when attached to the standard M. C. B. coupler, filling pieces are used, as shown in Fig. 15. Several of the roads have adopted a coupler with the back end built up as shown in Fig. 1, which makes a much simpler arrangement. The inner follower plate, A, receives the pulling stresses from the yoke end, the outer follower transmits them to the draw-bar stops and to the car framing. In the common form of draft gear the spring resistance is interposed between the follower plates; that is, the pulling and buffing stresses tend to reduce the distance between the follower plates and these are resisted by the springs which tend to hold them apart. This friction draft gear, in which springs play an important part, acts precisely on the same principle but the resistance of the springs is supplemented by vastly greater (about six times as great) frictional resistances which tend, both in pulling and in buffing, to prevent the follower plates from approaching each other. The way in which the frictional resistances are called into action, by the motions of pulling and buffing, and the manner of their release will command the admiration of those who follow this description.

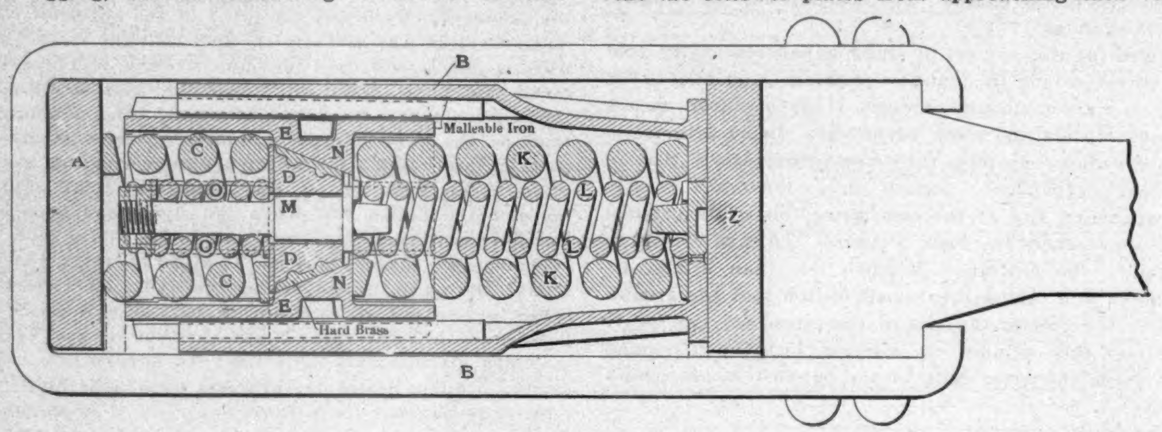


Fig. 1

Bearing against the follower plate, A, is a spring, C, the other end of which bears against a wedge, D, made in the form of a frustrum of an octagonal pyramid with hard brass facets, as shown in Fig. 1.

Surrounding the wedge are four pairs of malleable-iron segmental carriers, E, having inclined bearing surfaces, N, of the same angle as the wedge, as shown in Figs. 2, 3, 4, 5 and 6. These segmental carriers, E, have a central longitudinal rib cast upon them to strengthen and guide them. These ribs fit the grooves, F, in Fig. 9, loosely.

The other grooves of the frictional cylinder, Fig. 9, are filled by the hardened wedge bars, G, Fig. 7. The shape of these wedge bars is seen in Figs. 7 and 8. They rest upon the segmental carriers, E, as shown in the sectional views of Figs. 11 and 14, with the small inwardly projecting portions, marked H, in the lower view of Fig. 7, resting in cavities in the carriers, E. It is clear that if the carriers, E, are moved longitudinally to the right or left, the wedge bars, G, must move with them. The function of the preliminary spring, C, Fig. 1, is to force the wedge against the inclined surfaces, N, of the segmental carriers, and also to absorb the ordinary pressures on the draw bar due to the movement of the train. When the apparatus is placed in the yoke this spring is under a slight compression, which insures the parts being held tightly in position, thus preventing foreign substances from lodging between the bearing surfaces. The auxiliary preliminary spring, O, Fig. 1, gives additional pressure on the wedge. The main release spring, K, is used for returning the segmental car-

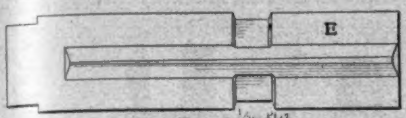


Fig. 2

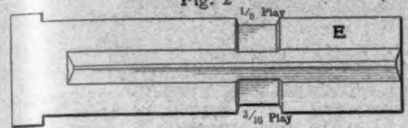


Fig. 3

Fig. 4

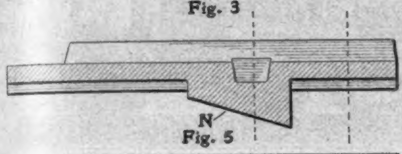


Fig. 5

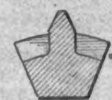


Fig. 6

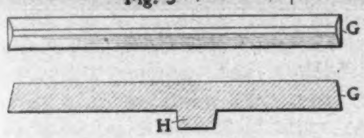


Fig. 7

Fig. 8

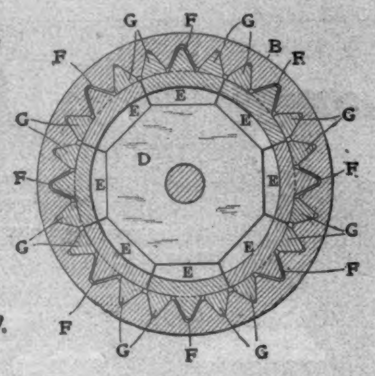


Fig. 9

riers and wedge bars to their normal position after the force to close them has been removed, and it also gives additional capacity to the device. The function of the auxiliary release spring, L, is to provide a sure release of the wedge from the segmental carriers, and it also increases the capacity of the device. The function of the release pin, M, is to relieve the pressure of the auxiliary release spring, L, against the wedge, when the device is being closed.

Operation.

When, either in draft or in buffing, the stress upon the draw bar moves the follower plates, A and Z, Fig. 1, toward each

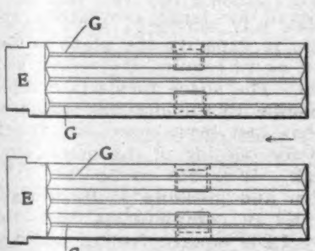


Fig. 10

Fig. 11

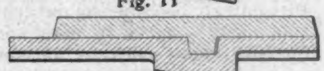


Fig. 12

Fig. 13

Fig. 14

other, the preliminary spring, C, is compressed, and if the pressure so applied is less than would be required to force the follower plate, A, against the release pin, M, the segmental carriers and wedge bars remain at rest, which insures against wear upon the frictional surfaces during the ordinary movement of the train. When the stress is sufficient to force the follower, A, against the ends of the segmental carriers, it will have forced the release pin, M, which projects slightly above the segmental carriers, toward the closed end of the cylinder, thereby relieving the pressure of the auxiliary release spring against the small end of the wedge. In this position the force necessary to compress the springs, C and O, is exerted against the large end of the wedge, and by the inclined surfaces it is transmitted through the segmental carriers to the wedge bars. A further increase of force against the follower plate, A, brings the segmental carriers and wedge bars into action, and in so doing the force exerted by the wedge upon the wedge bars produces friction between the wedge bars and the V-shaped grooves of the cylinder (which is tapered toward the closed end). The traverse of the wedge bars is completed when the follower, A, comes in contact with the cylinder, the release springs, K and L, having been compressed to about 80 per cent. of their capacity. During the movement of the wedge bars in the cylinder grooves the force exerted upon the wedge by the preliminary springs (about 20,000 pounds) remains constant, as their action is limited by the follower, A, bearing on the segmental carriers; the increased frictional resistance being due to the taper of the cylinder.

Upon the removal of the pulling stress at the coupler, the springs, C and O, are restored gradually to their normal size. The preliminary release spring, L, then pushes the wedge back and away from the segmental carriers, which it can do on account of the carefully studied angle of the facets, and in this condition the main release spring, K, bears upon the projections, N, of the segmental carriers and tends to press them to the left, which, when accomplished, will withdraw all of the wedge bars from their locked positions in the grooves at the small end of the cylinder. This constitutes a complete release of the friction device.

The carriers, E, are arranged in pairs with interlocking outer ends, as shown in Figs. 2 and 3, in order to prevent them from being put together in wrong order. Each carrier carries two of the loose wedge bars and the slots in the carriers in which the lugs of the wedge bars rest are of different lengths. In a set of two bars the first lug fits the slot, the second has 1/16 inch play, the third ⅛ inch play and the fourth 3/16 inch play, as indicated in Figs. 2 and 3. This is also clearly shown in the four sectional sketches, Figs. 11 to 14. If this is understood it will be clear that under the influence of the spring, K, the

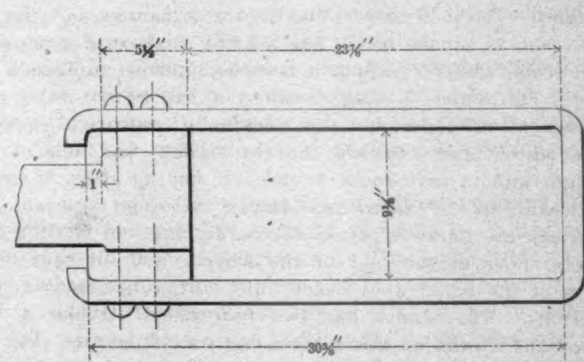
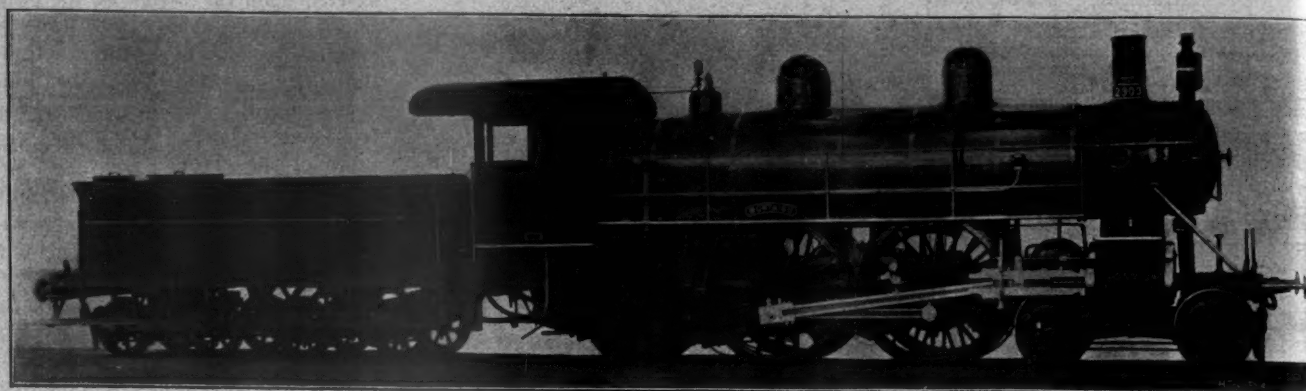


Fig. 15

top wedge bar, Fig. 11, will be released first and the others in succession as the space in the slots is taken up. Four bars are represented by Fig. 11, and when these are released the spring, K, releases four more represented by Fig. 12 and so on. Since there are eight carriers in all or four sets of two each, it is necessary for the spring, K, to release the wedge bars four at a time until all are free.

The operation of buffing is exactly similar to that of pulling, in that the follower plates are moved toward each other, but of course the load comes first upon the outer follower in this case. The application of the spring and friction resistances and the manner of fractional release are the same for pulling and buffing.

A large number of these draft gears are in use and the device has for a long time been past the experimental stage. It is successful under the severest conditions of service as stated in our description of the application to the tender of the very heavy locomotives of the Union R. R. in March. Not the least of its advantages are the effect of the absorption of shocks in collisions and the immunity from break-in-two accidents. Experience shows it to be almost impossible to break a train apart when fitted with this device unless the couplers are defective.



Atlantic Type Passenger Locomotive—French State Railways.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS.

ATLANTIC TYPE PASSENGER LOCOMOTIVE.

French State Railways.

Built by the Baldwin Locomotive Works.

By the courtesy of the Baldwin Locomotive Works the accompanying photograph of one of a lot of 10 Atlantic type locomotives recently built for the French State Railways is shown. These engines are for express passenger service. They are not large or powerful when compared with recent passenger locomotive development in this country, but they are interesting because of the acceptance of the piston valve and the Atlantic type in France. The firebox is narrow and the grate area but 35 square feet. The heating surface of 2,095 square feet seems small to us, but it is rather unusual in French practice. The boiler is long, because of the 15-foot tubes. The firebox is of copper and the working pressure is 213 pounds. The boiler tapers toward the rear. This was done to save weight and to save room in the cab, but its effect is scarcely noticeable in the engraving. Among the other noticeable features are the Baldwin piston valves, driving and trailing wheel brake shoes at the rear of the wheels, and oil cups on the sides of the boiler above each axle, with tubes leading to the journals. The tender has two four-wheel trucks, a water scoop and a running board extending its full length. The leading dimensions of the engines are as follows:

General Dimensions.

Gauge	4 ft. 9⅛ in.
Diameter cylinders	17¼ in.
Stroke	26 in.
Valve	Balanced piston

Boiler.

Diameter	58 in.
Thickness of sheets	11/16 in.
Working pressure	213 lbs.
Fuel	Soft coal

Firebox.

Material	Copper
Length	120 in.
Width	42 in.
Depth	Front, 71¼ in.; back, 67½ in.
Thickness of sheets	Sides, ⅝ in.; back, ⅝ in.; crown, ⅝ in.; tube, ⅝ in. and ⅞ in.

Tubes.

Number	246
Diameter	2 in.
Length	15 ft. 1 in.

Heating Surface.

Firebox	170.43 sq. ft.
Tubes	1,925.44 sq. ft.
Total	2,095.87 sq. ft.
Grate area	35 sq. ft.

Driving Wheels.

Diameter outside	84¼ in.
Diameter of center	78 in.
Journals	8 x 10 in.

Engine Truck Wheels.

Diameter	36 in.
Journals	6 x 10 in.

Trailing Wheels.

Diameter	54¼ in.
Journals	8 x 10 in.

Wheel Base.

Driving	7 ft. 3 in.
Rigid	14 ft. 6 in.
Total engine	26 ft. 8 in.
Total engine and tender	55 ft. 2 in.

Weight.

On drivers	71,905 lbs.
On truck	32,700 lbs.
On trailing wheels	34,450 lbs.
Total engine	139,055 lbs.
Total engine and tender	219,000 lbs.

Tender.

Diameter of wheels	36 in.
Journals	4½ x 8 in.
Tank capacity	3,600 gals.

NEW OFFICE BUILDING OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

The Westinghouse Electric & Manufacturing Co. has found it necessary to repeatedly add to its facilities for manufacturing, and with the present demand for large generators, even up to 5,000 and even 8,000 h. p., in capacity the plant at East Pittsburgh became so outgrown as to require the recent addition of 11½ acres in floor space. The space formerly occupied by the offices became indispensable to the manufacturing departments. A large building has just been completed for the offices which are now provided for outside of the manufacturing building at East Pittsburgh. It is 250 by 50 feet and 7 stories in height. It is fireproof and pleasing architecturally. Its appointments are noteworthy in completeness and character. Fireproof vaults occupy 1,200 square feet of space on each floor, and they furnish safe storage for plans and valuable records. The employment and store departments occupy the first floor. The rooms for the managing officers and the reception room, on the second floor, are specially convenient and attractive; they are well furnished and are in good taste throughout. The third floor is occupied by the Westinghouse Companies Publishing Department, the accounting offices and those of the auditing, paymaster's, treasuer's, legal and cost departments. The mechanical engineering department has the entire fourth floor, and the fifth is occupied by the electrical engineers. Two handsome dining rooms are located on the sixth floor, and this floor also provides for the telephone exchange for the works. A third dining room here is provided for the lady stenographers. The heating is by direct steam and the lighting and ventilation have been given unusual attention. The temperatures throughout the building are regulated by automatic themostatic valves. The elevators are operated on the electro-hydraulic system from power furnished by two Westinghouse "Type C" motors, operating pumps which force water from the low pressure to the high pressure tank. These are regulated automatically. The offices and all of the departments of the works are connected by a pneumatic tube system with a central exchange station. This comprises 12 sending and receiving tubes, furnishing service to all floors of the office building and connecting to important points in the works. The longest line is 3,500 feet and the circuit is maae through it at a speed of about 60 miles per hour. The system operates by a vacuum of about 24 ounces, which is sufficient for handling carriers weighing 8 lbs. The tubes are 2⅛ inches diameter and of brass. This system is employed for the distribution of mail and the transmission usually performed by messengers. The entire installation has been planned and executed with a view of ultimate economy in the operation of this vast establishment.

EDITORIAL CORRESPONDENCE.

Illinois Central.

Mr. Renshaw is entirely satisfied that the heavy locomotives recently built for this road, one by the Brooks and the other by the Rogers people, are doing what was expected of them, although they have not as yet been tested for coal and water consumption. The purpose of these engines was not, as first reported, to handle trains over Cairo bridge only, but to permit of hauling the same trains over the 95 miles between Carbondale and Fulton, Ky., that are hauled by the lighter engines over the rest of the road between Chicago and New Orleans. This short section contains the heaviest grades and is the only part of the road requiring very heavy locomotives. Engine No. 640 is handling trains of from 1,800 to 2,000 tons over 40-foot grades between Centralia and Cairo, with a steam pressure of 210 pounds. Last October this engine hauled a train of 83 cars, weighing 3,400 tons, from Kankakee to Chicago, 56 miles, at a rate of 12 miles per hour over grades of 26 feet per mile. These engines are used on the road and not, like the Union Railway engines at Pittsburgh, for very short runs. The road service necessitates a large amount of fuel and water, and Mr. Renshaw is considering the design of a tender to carry 9,000 gallons of water and 18 tons of coal. With the present tenders, which were described in connection with these locomotives, Mr. Renshaw has found it necessary to furnish a coal passer to assist the fireman. This additional expense seems likely to be a necessary accompaniment of such heavy engines in regular road service, but the advantage of the heavier trains is believed to render this expense negligible.

Artificial refrigeration is undergoing experiment on this road. The details of the system will be reserved until it has developed further. The apparatus occupies the space formerly taken up by one of the end ice boxes, saving the space of the other box for the freight. About 1,000 linear feet of small copper pipe furnishes the cooling surface, and through this pipe a chemical is evaporated. The chemical requires but 35 pounds per square inch to take the liquid form. It is passed into the coil as a liquid and evaporates, and while doing so absorbs heat after the manner of all systems of this general character. Power is taken by a belt from the axle to compress the refrigerating agent back to the liquid form and to circulate the air in the car. It is stated that the temperature may be kept down to about 5 degrees F. by this system. A good mechanical refrigerating system which is not too complicated appears to have a wide field for fruit and meat transportation. There is no delay for icing cars, and this, on a through run on this road, amounts to seven hours. The cost of the apparatus is to be compared with that of providing ice, and its weight, including that of the water for cooling the refrigerating medium, is less than that of the ice. The cost of the ice is saved, probably entire, because the interest on the investment will be returned in the form of fuel saving on account of the diminution of delays. The idea seems promising.

CONVENTION OF AIR BRAKE MEN.

The Air Brake Association held its seventh annual convention in Jacksonville, Fla., opening April 3. The first subject for discussion was: "Recommended Practice for Successful Handling of Passenger and Long Freight Trains." The committee report contained the following conclusions:

1. The air brake work required for a stop increases much more rapidly than the speed.

2. On a level grade the entire brake retardation is available for stopping.

3. On a descending grade a certain portion of the brake retardation is required to prevent a gain in speed.

4. On a descending grade the work required of each brake to prevent a gain in speed increases with the weight of the load per brake.

5. The brake retardation available for stopping on a grade is that in excess of what is necessary to prevent a gain in speed.

6. The brake retardation possible from a certain shoe pressure decreases as the speed increases.

7. The longer the distance (and consequently time) required for a stop, the further will it be prolonged by brake cylinder leakage.

The committee went carefully over the considerations of safety in letting trains down long steep grades, recommending frequent applications and great care, in entering the grades, to reduce speed to a point of safety. The use of hand brakes to hold trains making long stops on steep grades was recommended in order to guard against the starting of the train on account of leakage. Instructions for handling trains on heavy grades were given at length, and summed up by the committee.

In the discussion a leaning in the direction of a desire for pressures higher than 70 pounds appeared. In ore trains, especially, a higher pressure was needed for loaded cars, and 70 pounds was only enough for empty cars. One speaker favored an increase of 25 per cent. An increase in the size of reservoirs was recommended. The effect of doubling the capacity of the main reservoir was to greatly improve the releasing of the brakes of 50 and 60-car trains, with 40,000 cubic inches capacity, and it was possible to release the brakes at the rear of such trains before the slack would run out. The fact that some roads were using the air brake on 65 cars in one train called out favorable comment, in view of the limitation of the number of air braked cars in trains to 20 on certain roads. The excellent method of handling the air brakes on the Nashville, Chattanooga & St. Louis Railway were noted, and commended, as a result of the attention given to the care and operation of the brakes by the management of the road, and the painstaking records of the parting of trains.

In discussing the piping of cars, the effects of the very crooked train pipes on hopper cars was referred to. Recent cars of this type often had four elbows, and each of these was equivalent to 15 ft. of straight pipe in resisting the action of the brakes.

In a report upon the lubrication of brake apparatus it was shown to be as important to avoid excessive as it was necessary to give sufficient lubrication. The committee on this subject suggested a rule for the use of the air-pump lubricator. A feed of ten drops of Galena valve oil per minute for the first five minutes after starting the pump, and one drop per minute during the remainder of the run was recommended as good practice. The quantity depended, however, upon the condition of the pump.

Next to the handling of long trains, and trains of all kinds on mountain grades, the most important subject was regulation of the travel of brake cylinder pistons. The brake slack adjuster was considered necessary as a measure for overcoming the sliding of wheels. Without automatic slack adjusters even low pressure could not be depended upon to prevent sliding of wheels, but with the McKee slack adjuster one speaker had been able to increase the braking power to 90 per cent. without having a single case of wheels sliding in two months.

A novel electric locomotive crane, capable of lifting and transporting articles of the weight of heavy frogs and steel rails has been designed and built by the J. G. Brill Co., of Philadelphia, and will be illustrated and described in a future issue. The power is taken from a trolley similar to that of a street car, and the motors for hoisting and locomotion are under the car. The idea is a new one, and the advantages suggested by it are many and important. Such a crane would be very valuable in railroad shops and yards because of its convenience and flexibility. Electric power is now available in nearly all plants, and by stringing a system of trolley wires the entire storehouse and storage yards would be served by this crane. The tracks may be extended into the machine shops and the crane used for handling wheels, axles and heavy castings. A large railroad repair shop could probably keep several of them busy and the cost would soon be saved in the reduction of laboring gangs. The J. G. Brill Co. have one in their works and find it most satisfactory.

TRACTIVE POWER OF TWO-CYLINDER COMPOUNDS.

By C. J. Mellin.

Chief Engineer Richmond Locomotive and Machine Works.

The theory of the tractive power of compound locomotives appears to be of more general interest among railroad men than ever before, and, upon requests from a number of people, the writer submits herewith a development of it.

The conditions in starting a compound locomotive differ somewhat from those of the normal working of the engine, and, consequently, the tractive power is based on the latter condition, but it may be of interest to follow up what takes place in the cylinder from the moment the throttle is opened until the engine assumes its normal state of compound working.

On opening the throttle the steam enters the high-pressure cylinder direct, as in the case of a simple engine, and to the low-pressure cylinder, also from the throttle, through a passage generally governed by an automatic stop and reducing valve, so proportioned that the pressure (p) admitted to the low-pressure cylinder steam chest bears the same relation to the pressure (P) in the high-pressure steam chest as the high-pressure piston area (a) bears to the low-pressure piston area (A) or $p:P = a:A$, which give the same power on both sides of a two-cylinder compound engine.

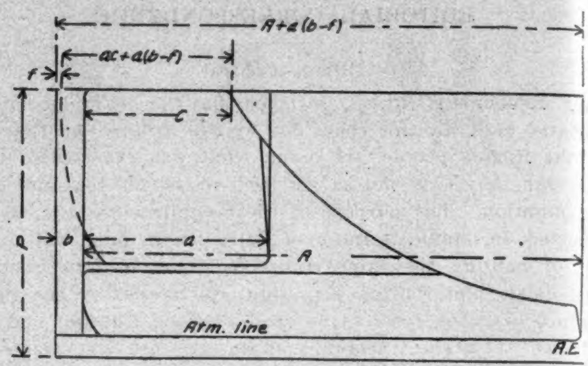
The receiver in the meantime being closed from the low-pressure cylinder by the intercepting valve, there is only atmospheric resistance to both pistons during the first stroke. After the second or third exhaust from the high-pressure cylinder this steam has accumulated in the receiver to the required initial pressure in the low-pressure cylinder, and the engine, if provided with an automatic intercepting valve, goes over into compound working without any manipulation on the part of the engineman; that is, the pressure in the receiver opens the intercepting valve, which valve, by its motion, closes the stop and reducing valve, whereby the admittance of live steam to the low-pressure cylinder is shut off and the high-pressure exhaust steam is admitted to the low-pressure cylinder. The engine is then working compound, and it is in this condition tnat its tractive power is to be calculated.

The resultant work of a compound engine is based on the low-pressure cylinder, and the general average pressure of the steam that is let into and expanded throughout the engine. The high-pressure cylinder enters the formula as a measurement of the initial steam volume, and it subdivides the work of the engine with the low-pressure cylinder, the former working in the upper stage and the latter in the lower stage of the range of pressure from the initial to the terminal. This subdivision also divides the range of temperatures in the same manner as that of the pressure, making the variation only one-half of its entire range in each cylinder, and makes it possible to utilize a maximum amount of the expanding power of the steam with the least variation of temperature or loss by condensation in the cylinders.

The initial volume of the steam used during one stroke of the engine is the volume of the high-pressure cylinder up to the point of cut-off plus the volume of the cylinder clearance. There has, however, been compression from a previous stroke that has made up part of the clearance, which will be subtracted from this volume to get the amount of steam supplied by the boiler to fill this space. Then we get the initial volume from which the work of the engine is obtained.

We now designate this volume, with reference to the high-pressure cylinder, calling the high-pressure cylinder volume = a, cut-off = c, the cylinder clearance = b and the compression = f, when the volume used is = $ac + a(b—f)$, a being the unit and c, b and f expressed in percentage of a. The final volume is that displaced by the low-pressure piston up to the point of release plus its cylinder clearance less the compression.

In designating this in same manner as that of the high-



Tractive Power of Two-Cylinder Compounds.

pressure cylinder by using capitals for corresponding quantities, calling the volume displaced by the piston to the point of release, E, we get the final volume $A E + A(B—F)$, or calling the space from the points of release to the end of the stroke G, we can signify the final volume by $A—(G A)+ A(B—F)$.

Again, by substituting the clearance, less the compression, $A(B—F)$, in the low-pressure cylinder with the volume from the point of exhaust to the end of the stroke, G A, and the clearance, less compression, of the high-pressure cylinder $a(b—f)$, which aggregate about the same amount, we eliminate several terms from the formula that in most cases will have to be assumed anyway, and we get a simpler expression of the whole problem, which then will be $A + a(b—f)$, and the number of expansions

$$N = \frac{A + a(b—f)}{ac + a(b—f)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

as illustrated in the sketch.

This being the foundation of the problem, we can proceed on known methods for its solution, where it will be noticed that the areas of the cylinders are substituted for volumes in the calculation, which may be done when the stroke of the pistons are the same.

Since the number of expansions are known, we get the theoretical average pressure

$$P_1 = \frac{P + \text{hyp. log } N}{N} — 15 \quad \ldots\ldots\ldots\ldots (2)$$

where P is the absolute initial pressure or boiler pressure plus the atmospheric pressure. The hyperbolic log, N, is found in any hand-book that treats on the subject of steam.

P_1 = the theoretical average pressure. The actual average pressure, P_2,, is about 80 per cent. of P_1, due to wire drawing of the steam in ports and passages, and we have the tractive power

$$T = \frac{d_1^2 P_2 S}{2 D} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

in which d_1 = diameter of the low-pressure cylinder, S = stroke of piston, and D = diameter of drivers.

This formula is derived from the fundamental formula

$$T = \frac{0.7854\ d^2 P_2\ 2\ S}{3.1416\ D}$$

which, after cancelling gives the above.

Now let us apply these formulas to an engine with 21-inch and 33-inch by 26-inch cylinders, 56 inches in diameter of drivers and 200 pounds boiler pressure (P = 215 pounds.) C = 85 per cent.; b = 8 per cent., and f = 2 per cent. of a. A being 850 square inches, and a being 340 square inches, we have from formula (1):

$$N = \frac{A + a\ (b - f)}{a\ c + a\ (b - f)} = \frac{850 + 340\ (0.08 — 0.02)}{(340 \times 0.85) + 340\ (0.08 — 0.02)} =$$

2.81 expansions.

The hyperbolic logarithm for 2.81 = 1.0332, hence we get from formula (2):

$$P_1 = \frac{P\ (1 + \text{hyp. log. } N)}{N} — 15 = \frac{215\ (1 \div 1.0332)}{2.81} — 15 = 140.5$$

pounds, and the actual average pressure $P_2 = 140.5 \times 0.80 =$ 112.4 pounds.

By inserting the value of P_2 in the third formula, we get

$$T = \frac{d^2\ P_2\ S}{2\ d} = \frac{33 \times 33 \times 112.4 \times 26}{2 \times 56} = 28{,}411 \text{ lbs.},$$

tractive power.

CORRESPONDENCE.

PROPORTIONS, HEATING SURFACE, TUBE AREA, AIR OPENINGS AND STACK AREA.

To the Editor:

Can you or any of the readers of your valuable paper tell me whether there is any accepted rule for the proportion in a locomotive between the area of the openings in the grate, the area of the openings of the tubes and the smallest area of the stack?

I do not remember having ever read anything on this subject and I shall be much indebted for information thereon.

Our standard freight locomotives designed and built in our shops have 960 sq. in. openings in the grate, 553 sq. in. openings of 230 tubes 1¾ inches inside diameter, and 189 sq. in. smallest area of stock. Taking the openings in the grate as 100, the openings of the tubes would be 58, and the stack 20.

J. G. BEAUMONT,
Superintendent of Machinery,
Arequipa, Peru, March 9, 1900. Southern Railway of Peru.

CHANGING THE CENTER OF GRAVITY OF A LOCOMOTIVE.

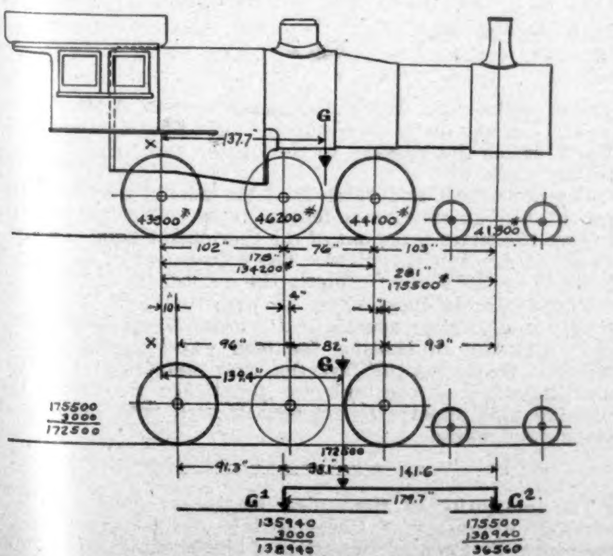
To the Editor:

On reading Mr. Cole's excellent articles on the center of gravity of locomotives in the last two numbers of your valuable journal, it occurred to me that a calculation recently made by the writer may be of interest to your readers.

It was proposed to modify the design of a heavy ten-wheel engine to increase the weight on the drivers and to reduce the weight on the truck. The locations of the drivers were to be moved forward as much as the necessary clearance of valve motion and other parts would permit. These clearances were found to allow the front and back drivers to be moved ahead 10 inches and the main drivers 4 inches. The problem was to find the new center of gravity and the new distribution of weight. The sketch shows the wheel-base and weight distribution of the original engine. To find its center of gravity, taking the moments in inch-pounds around the center line of the back driver, X — X, we have:

Weight.	Moment.
43,900 × 0 in. =	
46,200 × 102 in. =	4,712,400
44,100 × 178 in. =	7,849,800
41,300 × 281 in. =	11,605,300
Total..175,500	Total..24,167,500

and dividing this total moment by the total weight we have



Moving the Center of Gravity of a Locomotive.

137.7 inches, which is the distance from the line X — X to the center of gravity of the engine. The new center of gravity is found by taking the weights of the parts moved ahead and multiplying each by the distance moved. The sum of these products gives us the total moment or leverage to be added to that of the original design, and since we have not added anything to the total weight, dividing the new total moment of 24,467,740 inch-pounds by 175,500 pounds as before, we have 139.4 inches for the new center of gravity measured forward from the line X — X. As the weights involved may be of interest, I give this otherwise routine part of the calculation complete.

Parts Moved.	Lbs. Weight.	Inches Moved.	Inch-lbs. Moment.
Front driving wheel centers	4,000	10	40,000
Front driving wheel tires	2,380	10	23,800
Front driving boxes	1,000	10	10,000
Front driving axles	1,100	10	11,000
Front driving springs	480	10	4,800
Front driving spring hangers	250	10	2,500
Front driving spring seats and hooks	543	10	5,430
Front driving brake work	400	10	4,000
Front driving frame pedestal	500	10	5,000
Front crank pins and rods on front pin	884	10	8,840
Front equalizers	250	3	750
Links and front half of eccentric rods	455	6	2,730
Rock shafts and boxes	530	6	3,180
Reverse shaft, boxes and spring	332	6	1,992
Main driving wheel centers	5,000	4	20,000
Main driving wheel tires	2,500	4	4,000
Main driving boxes	1,000	4	4,000
Main driving axle	1,200	4	4,800
Main driving springs	480	4	1,920
Main driving spring hangers	250	4	1,000
Main driving spring seats and hooks	543	4	2,172
Main driving brake work	400	4	1,600
Main driving frame, pedestals, etc	500	4	2,000
Main crank pins and rods on main pins	2,036	4	8,144
Main equalizers	464	3	1,392
Eccentrics (sheaves)	520	4	2,080
Eccentric straps	600	4	2,400
Eccentric rods (back half)	70	4	280
Back driving wheel centers	3,950	10	39,500
Back driving wheel tires	2,380	10	23,800
Back driving boxes	1,000	10	10,000
Back driving axles	1,100	10	11,000
Back driving springs	480	10	4,800
Back driving spring hangers	250	10	2,500
Back driving spring hooks and seats	543	10	5,430
Back driving brake work	400	10	4,000
Back driving frame, pedestals, etc	500	10	5,000
Back crank pins and rods on back pins	840	10	8,400
Total moment added			300,240
Total moment of original engine			24,167,500
Total moment of new engine, lbs			24,467,740

divided by the total weight, 175,500 = new center of G. = 139.4 in.

As the three pairs of drivers are equalized together each wheel would be loaded equally above the springs; the only variation being in the dead loads or weight carried between the springs and the track. The dead load on the front and back drivers being approximately equal, we deduct the excess load (in this case about 3,000 pounds) from the main drivers. The center of gravity of the drivers is then found by adding the distances of each pair from the center line of the back one and dividing the sum by the number of pairs. This is following the same rule as used above, but if the weights are equal we can assume the most convenient figure, which is 1. Now we can consider the total weight (less the 3,000 pounds deducted) supported on two points; one G^2, the center of the truck, and the other G^1, the center of gravity of the three pairs of drivers. Having the location of the two points of support G^1 and G^2, and the point of the total load G, we can find the weight on either point, as G^1, by the principle of levers, thus:

$$\frac{172,500 \times 141.6}{179.7} = 135,940$$ pounds, which, after adding the 3,000 pounds previously deducted, equals 138,940 pounds, or the weight on drivers. By subtraction from the total we obtain the weight on the truck, 36,560 pounds.

The weight below the springs is not always readily obtained, and for preliminary or rough calculations I have found the table given below to be very useful. It gives the per cent. of weight on drivers carried below the springs.

	Per cent.
4 Eight-wheel engines averaged	26.1
3 Ten-wheel engines averaged	23.4
2 Four-wheel engines averaged	17.8
2 Six-wheel engines averaged	17.8
1 Twelve-wheel engine	26.5
3 Mogul engines averaged	20.3
3 Consolidation engines averaged	19.8

Hartford, Conn., April 21, 1900. F. K. CASWELL.

DEEMS' TEMPERATURE REGULATOR FOR LOCOMOTIVE TENDER FEED-WATER HEATERS.

The application of the exhaust steam from the air brake pump to heat the feed water in the tenders of locomotives is now quite common. It would be more so if it were not for the danger of getting the water too hot for the injectors. As a result of this danger enginemen are afraid to allow the water to get as hot as it ought to be for fear that the injectors will give them trouble. Mr. J. F. Deems, Assistant Superintendent of Motive Power of the C., B. & Q. R. R., has patented an automatic device to regulate the temperature of the water so that the benefits of heating may be had without this difficulty.

Mr. Deems has kindly furnished these drawings. He states

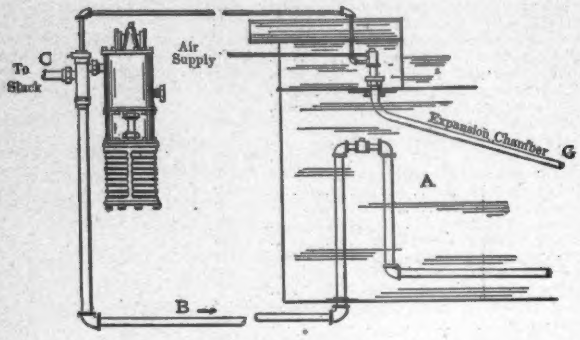


Fig. 1

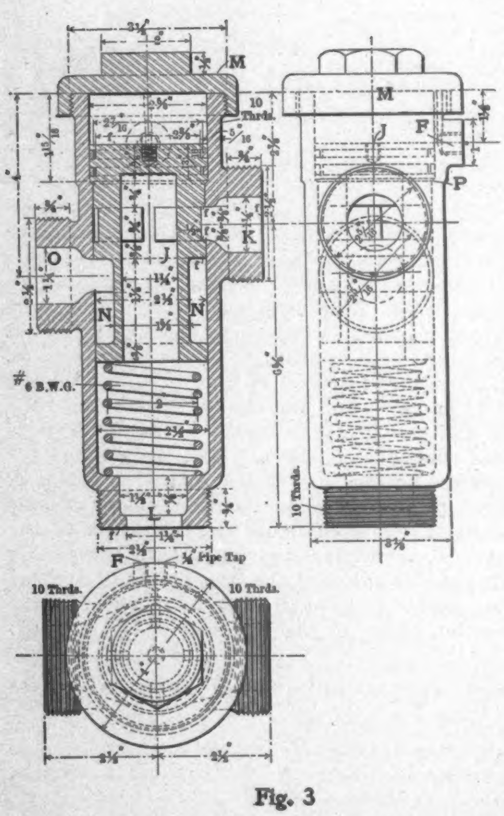


Fig. 3

that the temperature is held within a range of 5 degrees. The device has three principal parts; (1) a thermostat tube, G, placed in an inclined position in the water of the tank; (2) a valve controlled by the thermostat which admits air pressure from the air brake supply, to (3) a two-way valve, C, at the air pump by which the air pump exhaust is turned either to the stack or into the heater coil in the water tank. The thermostat or "expansion chamber" is a piece of 2 in. gas pipe containing approximately 450 cubic inches of water. Its upper end opens under a flexible diaphragm in the lower part of the valve shown in Fig. 2.

The regulating valve, Fig. 2, has two air pipe connections in its upper part. The upper pipe, B, admits air from the main reservoir to the double regulating valve. This regulating valve when in its middle position permits air to pass from the air supply into the lower pipe, D, and to the space above the piston of the exhaust steam valve, Fig. 3, pressing the steam valve downward against the spring and opening the passage for the air pump exhaust to pass into the tender tank. The steam passes through the valve and its passage to the stack is cut off. In Fig. 3 the exhaust enters at K and passes out at O for the stack, and at L for the tender. A cap, M, gives access to the interior.

If the device is adjusted to turn the exhaust toward the stack when a temperature of, say, 120 deg. has been reached, at that point the water in the expansion pipe raises the diaphragm of Fig. 2 and raises the double valve into its upper position. This cuts off the air from the exhaust steam valve and the air contained in the pipe leading between the two

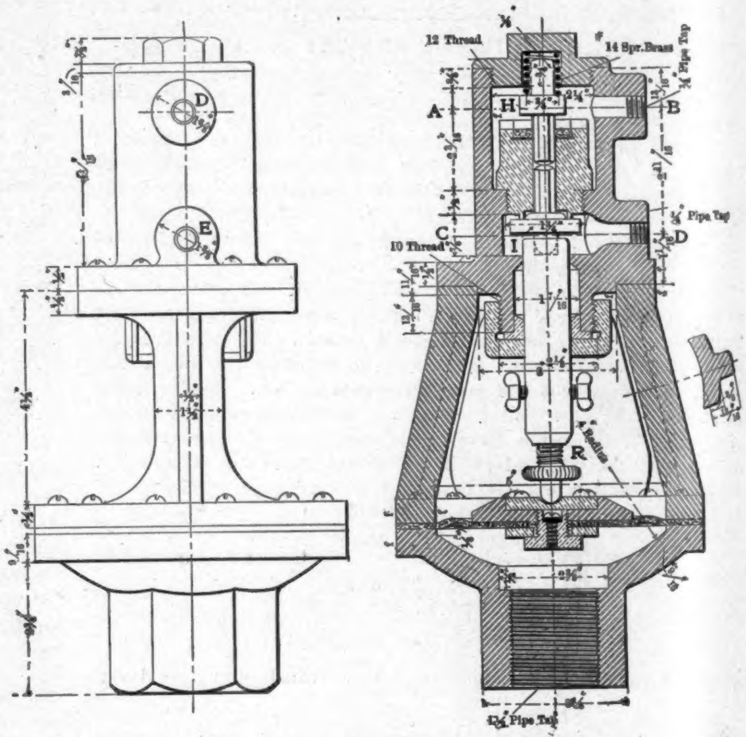


Fig. 2

valves leaks out. When the pressure runs down the spring under the exhaust steam valve, Fig. 3, moves the valve upward, closes the passage to the heater and turns the exhaust to the stack.

The upper seat and valve H of the double valve of Fig. 2 is provided as an emergency feature to be called into action only in case the water leaks out of the thermostat pipe. The amount of air used is infinitesminal. The adjustment of the regulation is made by the screw, R, above the diaphragm of Fig. 2.

The device is inexpensive to construct and it costs practically nothing to operate. It seems likely to remove the only difficulty in heating the feed water in the locomotive tender. Owing to the fact that the temperatures of the air and the water in the tank are practically the same, the expansion pipe appears to act equally well with large or small amounts of water.

The Institution of Mechanical Engineers and the Institution of Civil Engineers of Great Britain desire to combine with their next meetings a reception of the members of the American Society of Mechanical Engineers, who will visit England shortly. The Institution of Mechanical Engineers have arranged to hold their next meeting in London in the last week in June next, and the Grand Hall of the Hotel Cecil has been engaged for their annual dinner on June 27th.

A NEW PLAN CONCERNING THE PURDUE LOCOMOTIVE TESTING PLANT.

The locomotive laboratory of Purdue University was established for the purpose of instructing students, and during the eight years of its existence it has never failed to serve this purpose well. The opportunity which the plant offers for work of research has, however, never been lost from view, and in recent years small sums of money have from time to time been made available for such work. This has served to develop some facts for several committees of the Master Mechanics' Association and to advance several important lines of work projected by Prof. W. F. M. Goss, whose name is so closely associated with this admirable institution. Various commercial tests for which money has been received have helped to swell the volume of the business done. Thus far, however, the business has not been sufficient to completely occupy the plant. The instructional work, the research which can be paid for by the Purdue Trustees, and the commercial work, all combined, have not, in the past, been sufficient to warrant the maintenance of a permanent force of attendants about the plant, with the result that the work which has been accomplished has been done at a disadvantage and real progress has been slow. Moreover, the limitations arising from this course have prevented the acceptance of many opportunities for commercial work which, under more favorable conditions, could have been accomplished with profit.

It is the desire of the Trustees of Purdue that the locomotive testing laboratory shall be made to serve as large a sphere of usefulness as practicable. While unable themselves to provide funds for its continuous operation, they are ready to extend every encouragement to others who may assist to such an end. To sustain a permanent organization at the plant, and to provide supplies of fuel, oil, etc., needed for its continuance will require the expenditure of from $6,000 to $8,000 a year. It would seem not unlikely that the business demands of the whole country would equal this amount, at least for a single year. It is proposed, therefore, to ask those who are likely to be interested in the subject to subscribe for work to be don at times which may be agreeable between September 1, 1900, and September 1, 1901. Thus, Messrs. X. & Co. may signify their willingness to invest in the laboratory to the extent of $1,000; Messrs. Y. & Co. to the extent of $2,000, while individuals may come in for amounts as low as $100. In the event that a sufficient amount is subscribed to warrant an organization on the basis indicated, they may at any time within the 12 months indicated arrange to have work done and reported upon by the regular laboratory authorities with the expectation of paying a fair amount for each test or each investigation, which amount will be credited against the amount they subscribed.

The purpose of the charge and the basis upon which it will be fixed will be such as to cover labor and material accounts only. Nothing will be charged for the use of the plant, or for deterioration, or for repairs except such as may result from the progress of the individual work in hand. The laboratory authorities will hold themselves in readiness to quote in advance fixed prices for all work that may be proposed. An estimate of what may be accomplished for a given amount may be made from the following statement. To run the plant the daily labor costs will be about as follows:

One fireman	$2.50	
One coal passer	1.50	
One oiler and attendant	2.50	
One man for mounting mechanism	1.50	
Two permanent observers at $2.50	5.00	
One foreman	3.00	
Total		16.00
Offiffice expense in summarizing data and formulating report, chargeable to one day's running	6.50	
Allowance to cover loss for periods of enforced idleness	2.00	
Total expense per day (engine not running)		$24.00

This expense would be expected to continue whether the engine was actually under steam or not. The observers and foreman at such times assisting in the office work, while the less expensive labor would be making needed preparations for the next run. To the above estimate covering fixed charges, there is to be added, for days when the engine would be under steam, an additional item of $15 to cover cost of fuel, oil and other supplies, making the total cost per day (engine running) $39.

It will be seen on the basis of the above estimate that one desiring a test of a valve, or a valve mechanism, or of an exhaust nozzle, or any small thing which could be determined in a single day's running, could secure all the information desired for something less than $100. This statement, while merely an indication of the basis upon which it is proposed tc make charges for work done, is offered for the guidance of proposed subscribers.

The character of the work which may be undertaken may be anything for which the plant is adapted. It may include a determination of the value of different fuels used under conditions of locomotive service; tests of improvements in the parts of locomotives, as, for example, valve gears and other portions of the mechanism, stacks, draft appliances, lubricators, etc., or it may include tests of complete locomotives. Thus, any locomotive within the capacity of the plant could be received at the laboratory, mounted, subjected to a series of careful tests, and delivered from the laboratory ready for shipment.

It is recognized that the fact that proposed patrons are asked to signify their intention some months before work can be undertaken, has a distinct disadvantage in the working out of the proposed scheme, but inasmuch as the University cannot venture money in a business operation, the condition leading to the objection is a necessary one, though in part, at least, compensated for by the tender on the part of the University of the free use of an expensive plant and the consequent low price at which it is proposed to do work.

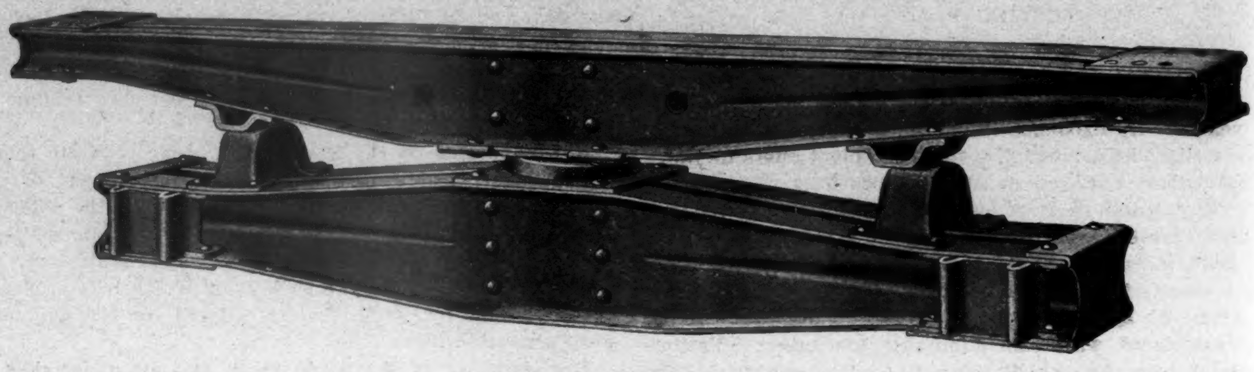
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Semi-Annual Meeting.

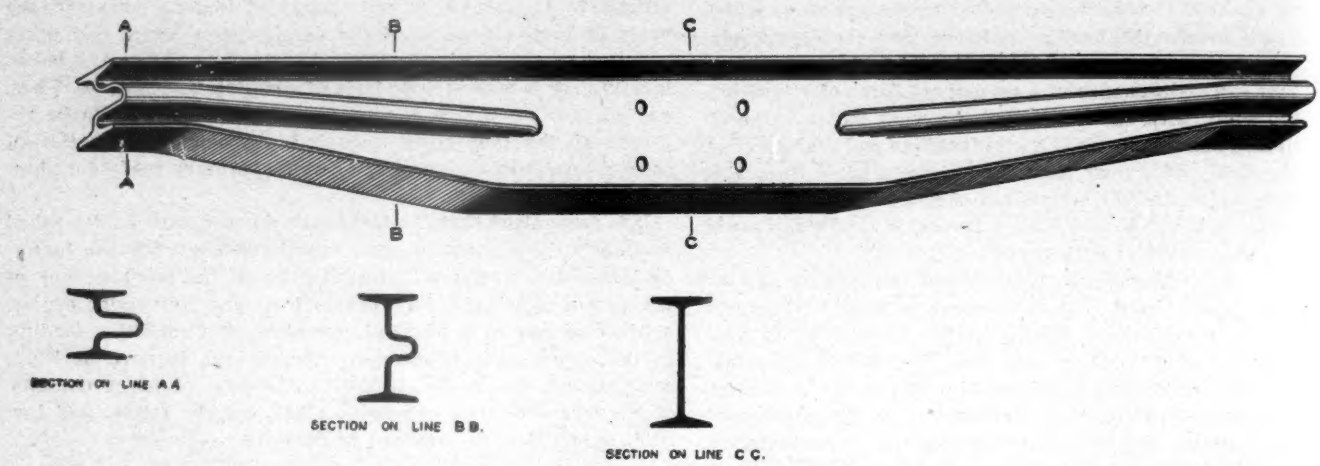
The forty-first meeting of the American Society of Mechanical Engineers will be held in the Grand Hotel, Cincinnati, May 15 to 18. The address of welcome will be delivered by the Hon. Gustav Tafel, Mayor of Cincinnati, at 8.30 p. m., May 15, and the response will be by Mr. Charles H. Morgan, President of the society. The program of subjects is as follows:

Rockwood, Geo. I., "On the Value of a Horse Power"; Yaryan, H. T., "Hot Water Heating from a Central Station"; Aldrich, W. S., "Systems of Efficiency of Electric Transmission in Factories and Mills"; Guest, J. J., "Design of Speed Cones"; Thurston, Robt. H., "Multiple Cylinder Engines"; Magruder, Wm. T., "The Gas Engine Hot-Tube as an Ignition Timing Device"; Goldsmith, N. O., "Water Softening Plant of the Lorain Steel Co."; Higgins, M. P., "Education of Machinists, Foremen and Mechanical Engineers"; Herschmann, Arthur, "The Automobile Wagon for Heavy Duty"; Cooley, M. E., "A Test of a Fifteen Million High Duty Pumping Engine at Grand Rapids, Mich."; Goss, W. F. M., "Tests of the Snow Pumping Engine at the Riverside Station of the Indianapolis Water Company"; Ball, B. C., "Cylinder Proportions for Compound and Triple Expansion Engines." Topical discussions: "What Does It Cost to Run Trains at High Speed?" "Protection of Pen-stocks from Corrosion."

The shops of the Evansville & Terre Haute Railroad at Evansville, Ind., are being greatly improved under the administration of Mr. A. C. Hone, the Superintendent of Motive Power and Rolling Stock. Mr. Hone is a young man and a technica school graduate. He has put new life into the motive powe department and has made important improvements. The buildings have been painted, new stationary engines and boilers put in, and the entire equipment has been brought up to a state of modernism in condition and appearance. Five or six engines are in the shops at all times for overhauling, as well as about the same number of coaches, baggage and other cars.



The Bettendorf I-Beam Bolsters.



The Bettendorf I-Beam Bolsters.

THE BETTENDORF I-BEAM BOLSTER.

New Method of Manufacture.

These bolsters have been in use for several years and their record is good. The designer had chiefly in mind the advantage of the I-beam section in the distribution of metal in the bolsters in order to secure the maximum of strength with a minimum of weight, together with the advisability of using the smallest number of parts and the selection of material which would permit of making repairs without great expense or difficulty. In the structure the importance of sufficient stiffness to keep the side bearings clear of each other under the loads and the wear and tear of service was considered of first importance, because of the well-known troubles and wastefulness resulting from bolsters being "down on their side bearings."

These engravings show a pair of bolsters complete and a view of one of the I-beams of a body bolster illustrating the new method of manufacture. The I-beams are of open hearth steel and the former practice of cutting out a portion of the web at each end and dovetailing the edges together has been abandoned as unnecessary. The present practice is to press folds into the web, deep at the outer ends and running out into the flat web near the center, and to do this in a powerful hydraulic press without heating the I-beam. The sectional views show the form of these folds and the complete view shows their neat appearance in the finished bolster. An incidental advantage of this process is the severe physical test which the material undergoes in this cold pressing process. Defective or poor qualities of steel will at once be revealed before the construction is completed.

A variety of designs have been brought out for adapting these bolsters to cars of various kinds, for example, those with low side sills, cars with the American Continuous Draft Gear and those with draft timber passing through the bolsters. These bolsters are also easily adapted to any form of truck construction. A very attractive design has been made for body and truck bolsters for 80,000-lb. capacity cars. In these large capacity body bolsters a plate is carried across the top and a short distance around the ends. In the truck bolsters the plate is carried across the lower face and around the ends. This construction provides increased capacity and adds to the resistance to longitudinal, lateral and vertical shocks.

The Cloud Steel Truck Co., manufacturers of the Bettendorf bolsters, also make the Cloud pedestal and diamond frame trucks. The bolsters are now in use on more than 40 railroads. They are spoken of as "examples of good engineering in car construction."

The following railroad officers have received appointment to the Paris Exposition: Mr. A. E. Mitchell, Superintendent of Motive Power of the Erie; Mr. Wm. Renshaw, Superintendent of Motive Power of the Illinois Central; and Mr. W. T. Reed, Superintendent of Motive Power and Machinery of the Seaboard Air Line, have recently accepted appointments as American jurors in Class 32, Group 6, Railway Appliances. Dr. C. B. Dudley, Chemist of the Pennsylvania Railroad, has been appointed delegate to the Congress on Chemistry. Mr. J. F. Wallace, of the Illinois Central, and President of the American Society of Civil Engineers, has been appointed delegate to the Congress on Tests of Materials in June. Mr. L. F. Loree, General Manager of the Pennsylvania Lines West of Pittsburg, has accepted the appointment as delegate to the Railway Congress in September. Mr. J. J. Ramsey, Vice-President and General Manager of the Wabash, has been appointed delegate representing the United States Government at the Congress, and also delegate to represent the American Railway Association.

THE "K. A. K." UNDERGROUND ELECTRIC CONDUIT APPLIED TO CABLE RAILWAYS.

We have received from Mr. O. S. Kelly, of Springfield, Ohio, information concerning the "K. A. K." system as applied to cable railway conduits, also drawings from which the accompanying engravings were made.

A glance at the section of the conduit shows how the electric feeders, insulators and conductors are arranged, to avoid interference with the regular operation of the cable system. In Figs. 1 and 3 the important details of the system are shown. The rails are supported on channel iron ties, which are secured to the yoke, which is of cast iron. The steel pieces, C, are placed directly upon the top of the yoke with one side turned at right angles to form the drip into the conduit. The insulators, D, support malleable pieces, E, on which lips are provided to close around the conduit feeder tubing, G, which is of iron pipe lined with treated wood shown in section at O. The feeder cables, H, pass through these conduits. The tubes are air tight to avoid difficulties with atmospheric and other moisture.

The conductor rails, I, are bolted to the malleable castings, E, as shown in Fig. 3. The conductors are bonded at the ends by heavy flexible copper strips. Provision is made for contraction and expansion in the joints, and also for slight movements of the insulators. The trolley contacts are made by the two springs, K, K, of flat steel or spring brass. They carry cast iron shoes, J, on their lower ends for making contact with the conductor rails and as they are simple and inexpensive, renewals may be cheaply made. The springs, K, are carried in opposite directions at their lower ends; they pass through and are supported in insulating material shown at L, in Fig. 3, which is protected by the steel covering, M,

FIG. 2

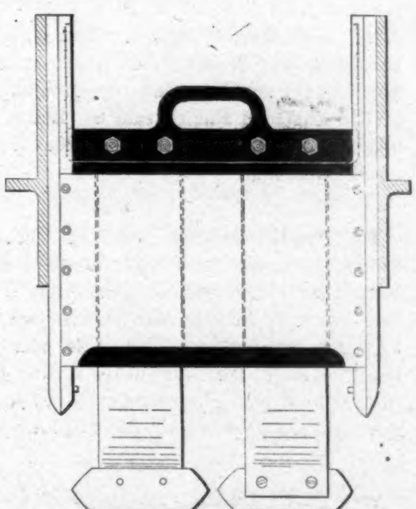


FIG. 1

this being fitted loosely in the base, N, which is permanently secured to the car truck. The springs, K, are fastened at the top by means of the insulating fiber strips, R, and pass loosely through the insulations, L, of the casing, M. The connection to the motors are made by means of the binding posts shown in Fig. 1.

The trolley is raised from the slot by means of the handle on the top of the insulating strip of Fig. 1. This raises the springs, K, and draws the shoes away from the conductor rails and brings them together at the bottom of the casing as seen in Fig. 2. The casing, M, and the shoes are then drawn from the slot. In this system manholes are provided from 300 to 500 feet apart. In these the fuse connections are placed and provisions are made for draining the slot into the sewer. The

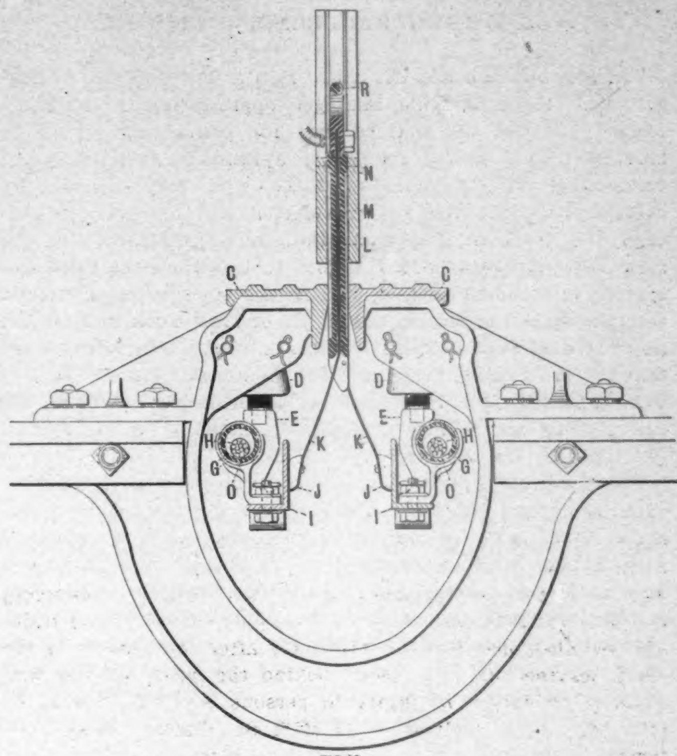


FIG. 3

fuse connections are made with heavy copper wire on insulated screw handles which may be readily detached or replaced without danger. The conductor rails end at the manholes and at these points they are connected to the feeders through the fuses. This construction renders it easy to locate defective insulation, and also prevents disabling the whole line or large part of the line because a grounding of one of the conductors disables one section only. With the return feeder system electrolysis and its serious consequences are entirely prevented. It is obvious that this system may be used in connection with overhead trolleys, the overhead and underground trolleys being connected with the same controlling devices.

THE PROTECTION OF STRUCTURAL METALS FROM CORROSION.

Prof. A. H. Sabin of New York recently delivered an address before the Engineers' Club of Philadelphia upon "The General Chemical Aspects of the Corrosion of Structural Metals, and the Principles Involved in their Protection," and illustrated his remarks by the exhibition of 235 steel and aluminum plates which were exposed for about two years to the action of fresh and salt water. There were originally prepared about 300 plates, each 12 inches wide by 18 inches long, and thick enough not to buckle, and these were divided into three sets, one being placed in the fresh water in Lake Cochituate, near Boston; another in the sea water at the New York Navy Yard, and the third in the sea water at the Norfolk Navy Yard. The plates, after being made perfectly clean under a wire brush, were coated with oil paints, varnishes or enamel paints, with a variety of pigments, so that a great number of different coatings were tested. The results seemed to show in general that in pigment paints the character of the pigment makes little difference in the permanency of the coating. Oil paint seemed to wear much worse than varnish paints, while of the latter, those containing a larger proportion of oil are the best. Baking is not generally beneficial, except in the case of enamels. Fresh water, of course, proved to be much less severe than salt water upon the coatings. Prof. Sabin also briefly described the commercial process of making paints and varnishes.

A SAFE THIRD RAIL ELECTRIC SYSTEM.

The Metropolitan Electric Third Rail & Traction Co., of Boston, Mr. George W. Hills, manager, appreciating the tendency toward the use of a third rail for conducting power to moving trains, has developed a system for rendering the conducting rail harmless to those who may accidentally come into contact with it. The electric elevated roads in Chicago, the Brooklyn Bridge and the electric installation on the New York, New Haven & Hartford R. R. all use the third rail system, and it will be used also in the application of electric traction upon the Manhattan R. R. of New York and on the new elevated lines in Boston. This is a satisfactory indication that the third rail is to be used for the heavier electric railway work, and this led to the study of methods for rendering the rail safe by Mr. George F. Gale, the inventor of the system developed by the company referred to.

The third rail is divided up into short sections insulated from each other, and these are brought into electrical contact and made "live" rails by connecting switches, operated automatically by the presence of the train in the sections in such a way as to put current from the feeders into the conducting rail only for that part of the rail actually in use by the train. The switches open again immediately after the passage of the train, leaving the rail "dead" behind the cars. In this way there is no danger of injury to persons who may touch the rail. Mr. Hills' address is 70 Milk St., Boston, Mass., and further information may be had from him.

PERSONALS.

Mr. R. H. Soule will open an office in New York May 1, as Consulting Mechanical Engineer.

Mr. John M. Egan, Vice-President of the Central of Georgia, has been elected President, to succeed the late H. M. Comer.

Mr. F. A. Cruger has been appointed Purchasing Agent for the Northern Steamship Company, with headquarters at Buffalo.

Mr. Chas. J. Canfield has been elected President, General Manager and Purchasing Agent of the Manistee & Grand Rapids, vice John Canfield, deceased.

J. E. Gould, General Foreman of the Columbia Shops of the Ohio Central, has been appointed Master Mechanic of the Cincinnati Southern at Chattanooga.

Mr. David Brown has been reappointed to his old position as Master Mechanic of the Delaware, Lackawanna & Western, at Scranton, Pa., which he resigned last December.

Mr. William White, Master Mechanic of the Illinois Central at Memphis, Tenn., has accepted an appointment to a like position on the Lake Erie & Western to succeed the late P. Reilly.

Mr. Charles Steele of New York, a member of the firm of J. P. Morgan & Company, has been elected by the Directors of the Lehigh Valley and also by the Directors of Erie to fill the place of the late C. H. Coster.

Mr. W. B. Gaskins has been appointed Superintendent of Motive Power and Machinery of the Pecos Valley & Northeastern, with headquarters at Roswell, N. M., in place of Mr. C. M. Stansburg, who has resigned.

Mr. Arthur Dufty, who has been connected with the Motive Power Department of the Central Railroad of New Jersey for some months past, has been promoted to the position of Foreman of Machine Shops at Elizabethport, N. J.

Mr. Colin M. Ingersoll, Jr., heretofore Assistant to the President of the New York, New Haven & Hartford, has been appointed Chief Engineer of that road, vice Mr. F. S. Curtis, recently elected Fourth Vice-President of the company.

Mr. George A. Barden has been appointed Eastern agent of the Standard Pneumatic Tool Co., with offices at 619 Washington Life Building, 141 Broadway, New York. He was formerly Superintendent of the works of the company.

Mr. Geo. M. Brown, Chief Engineer of the Saginaw district of the Pere Marquette, and who was Chief Engineer of the Flint & Pere Marquette for 30 years, has tendered his resignation to devote his entire time to lumbering interests.

Mr. E. P. Bryan, Vice-President and General Manager of the Terminal Railroad Association of St. Louis, has resigned to accept the position of General Manager of the New York Rapid Transit Subway Company, which is to build the underground railroad in New York.

Mr. Joseph Lythgoe, Superintendent and General Manager of the Rhode Island Locomotive Works of the International Power Company, and Mr. John Howarth, Assistant Superintendent of the same company, have resigned. Mr. John R. McKay will succeed Mr. Howarth.

Mr. George H. Kimball, who was formerly Superintendent and Chief Engineer of the Columbus, Sandusky & Hocking, has been appointed Chief Engineer of the Pere Marquette, succeeding George M. Brown, resigned. Mr. Kimball's headquarters will be at Grand Rapids, Mich.

Mr. J. O. Pattee, who left the position of Superintendent of Motive Power of the Great Northern January 1, 1900, has been appointed Superintendent of Locomotive and Car Department of the Missouri Pacific and St. Louis, Iron Mountain & Southern system, vice Mr. Frank Rearden, resigned to engage in other business.

Mr. Frank Rearden, who has been Superintendent of the Locomotive and Car Department of the Missouri Pacific since November, 1890, has resigned that position. Previous to December, 1888, he was Master Mechanic of the Missouri, Kansas & Texas, at Denison, Tex., and was then Master Mechanic of the St. Louis, Iron Mountain & Southern at Little Rock until he received the appointment of Superintendent of Locomotive and Car Department of the Missouri Pacific.

Mr. J. F. Deems, Master Mechanic of the Chicago, Burlington & Quincy, at West Burlington, Iowa, has received just recognition for his services to the company by a promotion to the position of Assistant Superintendent of Motive Power of that road. Mr. Deems began his railroad career as apprentice in the shops of the Baltimore & Ohio. He left that road in 1889 to enter the service of the Chicago, Burlington & Quincy. He will continue to make his headquarters at West Burlington, Iowa.

Mr. Dwight C. Morgan has been appointed Engineer Maintenance of Way of the Chicago & Alton, with headquarters at Kansas City, Mo. Mr. Morgan began railroad work in 1890 as Assistant Engineer in locating and building the Northern Pacific in Montana and Idaho. Besides holding responsible positions on the Southern Pacific and Illinois Central, he served for three years as Engineer of the Illinois Board of Railroad Commissioners. He entered the service of the Chicago & Alton in 1899 as Assistant Engineer.

Mr. A. Th. Ornhjelm, Mechanical Engineer of the State Railways of Finland, recently favored us with a pleasant call. He has been in this country in connection with locomotives recently completed for those lines by the Baldwin Locomotive Works, and has also made a study of American railroad methods. He considers our locomotives particularly interesting because of their enormous power, but finds the finish and care in fitting rather disappointing. In Finland much is made of grinding-in and accurate fitting of parts. In car construction he received many important suggestions from our practice which appeared to be directly applicable to the conditions in Finland, where, heretofore, English methods in car design had been almost exclusively followed. The Norfolk & Western steel frame coal car of 80,000 pounds capacity, illustrated on page 100 of our April issue, appealed to him particularly as an example of merit in our practice which was suggestive and applicable in modified form for the use of the lines he represented. In visiting the car building plants of this country he was permitted by the courtesy of Mr. S. P. Bush and Mr. J. J. Hennessey to examine the car shop methods of the Chicago, Milwaukee & St. Paul at West Milwaukee. He was impressed with the system employed there, and considered it not inferior to those seen in the largest of the car building establishments of this country which he visited. Among other interesting matters concerning practice in Finland, where civil service rules govern appointments and promotions, he mentioned the fact that it was customary for young men to serve for a time as volunteers without pay before taking examinations for appointment to official positions. He himself had served two years in this way without compensation. Mr. Ornhjelm is a subscriber to the "American Engineer." His entire conversation indicated that foreign engineers are seeking more than ever before to inform themselves upon railroad progress in this country.

BOOKS AND PAMPHLETS.

The Boston Belting Co., 256 Devonshire St., Boston, have issued a little pamphlet entitled "Do You Know?" of 20 pages, containing a list of the mechanical rubber goods which they manufacture. It suggests the importance of this industry, which reaches into all lines of transportation and manufacture.

Proceedings of the South African Association of Engineers. Vol. V., 1898-1899.

This volume contains a discussion on Tests of a King-Riedler Air Compressor, Notes on Electric Lighting Supply, Isolated Winding Plant at Ferreira Mine, Three-Phase Electrical Transmission of Power, Notes on the Manufacture of Calcium Carbide, and the proceedings of the seventh annual meeting. Copies may be obtained from Eden Fisher & Co., 6 Clements Lane, Lombard St., London, E. C.

The Wm. Powell Company, 2525 Spring Grove Avenue, Cincinnati, Ohio, have issued a new catalogue and price-list "No. 7," giving information concerning their specialties used by engine builders, mills, furnaces, transportation companies and pipe fitters. It contains illustrations and information concerning a very large variety of valves, lubricators, oil feeders and grease cups. The importance of making valves with a view of regrinding is emphasized. Among the lubricators we note the patent "Star" duplex condenser and double "up-feed" locomotive lubricator which was illustrated on page 125 of our April issue. The pamphlet has 253 pages and is convenient for the pocket. It has a number of colored pages scattered through the book, with useful information concerning the use of steam, horse power of boilers and engines and the use of belting. This catalogue should be kept at hand by all who use steam specialties because of its scope and convenience.

"Colorado via the Burlington Route" is the title of a new pamphlet on Colorado just issued by Mr. P. S. Eustis, General Passenger Agent of the Chicago, Burlington & Quincy. The past year has brought out an unusual number of noteworthy railroad advertising publications, but this one surpasses them all in attractiveness. The whole work is in excellent taste and the production is a book so handsome that it will find its place among the nice things one likes to preserve. It has another and greater value as a guide to the wonderful attractions for which the tourist loves Colorado. The illustrations are well executed half-tones from the copyrighted photographs of the Detroit Photographic Company; the text is by James Steele, and these are combined with good printing and tasteful arrangement. Copies may be had by sending a request accompanied by six cents in stamps to Mr. P. S. Eustis, General Passenger Agent, 209 Adams Street, Chicago.

The Ball Bearing Co., Watson St., Boston, manufacturers of ball and roller bearings for all kinds of machine construction, shafting and vehicles, have issued a "Twentieth Century Catalogue" describing the forms of these bearings which are regularly manufactured and carried in stock. It is beyond the possibilities of a catalogue to show all of the forms they are prepared to make. With special machinery and a trained organization they are ready to take up any desired special work of this character. Among the illustrations we notice one of thrust collar roller bearings for heavy pressures which appears to be very desirable for cranes and turn-tables where heavy loads must be provided for in small spaces. The catalogue presents a surprising variety of bearings, and in connection with each size and style the working loads are given. The pamphlet is well printed and bound in durable flexible covers. The present activity of the company indicates that Mr. W. S. Rogers, the General Manager, has used his railroad experience very effectively in the two years of his connection with this concern. The work is now far behind the orders, and machinery soon to be installed will double the capacity of the plant. A rec[illegible]addition of 10,000 square feet of floor area has been made to the factory. A large field for ball bearings is represented by an engraving of an automobile on the back cover of the catalogue.

Boston & Maine Publications.—In its mission of promoting and bringing New England into prominence as a vacation and tourist resort, the Boston & Maine Railroad endeavors to place before the public descriptive matter that is interesting, instructive and authentic.

The illustrations used in the various publications are from pictures taken expressly for the Boston & Maine Railroad by one of the most noted landscape photographers in the country and are veritable works of art.

Last year three portfolios were added to the list of illustrated publications which bear the following titles: "New England Lakes," "New England Rivers" and "Mountains of New England." These portfolios contain half-tone reproductions 4 by 6 inches in size. For the present season two additional portfolios have been prepared, namely: "Sea Shore of New England," and "Picturesque New England" (Historical-Miscellaneous).

In the Sea Shore Portfolio, among the thirty odd views of the rugged New England shore is a distant outline of Grover's Cliff, at Beachmont. In the vicinity of Marblehead are pictures of the surf and of the ancient wharves and of scenes in the harbor; then there is a picture of the "Singing Beach" at Manchester on the North Shore. Gloucester affords a variety of scenic display which depicts harbor and shore scenes. Further down the shore are vistas of picturesque surroundings at Ipswich Bluff, in the vicinity of Newburyport and at Salisbury. Of Hampton Beach and the Isles of Shoals there are several views, as well as York Beach. Likewise of Kennebunk and Old Orchard there are several delightfully pleasing representations of familiar places.

The Picturesque New England Portfolio is indeed one of the most interesting of the series, as it treats of a variety of subjects with which all are acquainted. Pictures are shown of the birthplaces of Whittier, Hawthorne, Rebecca Nourse, Horace Greeley, and President Pierce, while the Revolutionary reminders include illustrations of the Munroe Tavern; the Monument and Minute Man Statue at Concord, Mass.; the Governor Craddock House at Medford; and General Gage's Headquarters. The Colonial period is suggested in a collection embracing illustrations of the Frary House, the Governor Wentworth Mansion and the Hannah Duston Monument. The rural districts are attractively displayed in numerous views of inland scenes in the vicinity of Hadley, Lancaster and Groton, Mass., and Charlestown, N. H.

Either one or all of these five portfolios can be obtained by sending six cents in stamps for each book to the General Pass. Dept., B. & M. R. R., Boston, Mass.

Les Moteurs a Explosion Etude a L'Usage des Constructeurs and Conducteurs d'Automobiles. Par George Moreau. Published by Librarie Polytechnique, Ch. Beranger, Editor, 15 Rue des Saintes-Pères, Paris, 1900.

This book is an elaborate mathematical study of small explosive motors, having particular reference to those for motor carriages. It is intended for mechanical engineers who are engaged in designing and constructing such motors. It contains a theoretical study of small internal combustion engines, a critical examination of their cycles, consideration of the power transmission from the pistons of the motors to the axles, the internal friction of these motors and machinery of motor carriages, a discussion of the operating parts of motors, including governors and transmission devices. A general chapter treats of the thermal values of gas and oil for motors and the quantities of air required for combustion. Another chapter deals with the power of motors, their heat losses, tests, road trials and races. The treatment of tests with conclusions upon which to base designs and the information for guidance in the design of these motors which the title of the book leads the reader to expect are not quite satisfying, but as a theoretical study with the deduction of formulas it is very successful.

EQUIPMENT AND MANUFACTURING NOTES.

McCord & Co. have moved their Chicago offices to 1475 Old Colony Building.

The Chicago Pneumatic Tool Co. have moved their New York offices from 122 Liberty Street, to No. 95 of the same street.

There are 8,000 regular employes on the rolls of the Baldwin Locomotive Works, and the present activity represents an output of 1,200 locomotives per year, or 4 for every working day.

Mr. Samuel B. Hynes has been elected Secretary of the Safety Car Heating and Lighting Co., with office in Chicago. He succeeds Mr. C. H. Howard, who has resigned to accept a position with another company.

The Detroit Graphite Mfg. Co., Detroit, Mich., have issued a card directing attention to the time and corrosion resisting properties of their "Superior Graphite Paint," particularly for the protection of exposed metal and wood surfaces.

The Chicago Pneumatic Tool Co. have been informed by Naval Constructor Belianskie of the Russian Navy that the new Boyer pneumatic drill has been very successful and satisfactory in submarine work upon the sunken battleship "Apraxin" of that navy. In an illustrated lecture by this officer before the Marine Society of St. Petersburg, upon this drill, this officer demonstrated that it will bore through granite and other hard substances under water as well as in the air.

In the article on "Rapid Transit in New York," which William Barclay Parsons, chief engineer of the Rapid Transit Commission, contributes to the May Scribner's, he says that, after the railway is built and the street surface restored, except at portions at the northern termini, where there are viaduct constructions, there will be scarcely any evidences of its existence. The only outward sign will be the glass-covered stairway approaches leading down from the sidewalks to the stations. Mr. Parsons makes the point that it should be called a subway, not a tunnel.

Mr. A. C. Hone, Superintendent of Motive Power of the Evansville & Terre Haute R. R., has extended the compressed air system at the Evansville shops for the purpose of spraying freight cars. Recent tests on this road of Lucol paint have proven very satisfactory. One coat of this paint is held to be equal to two coats of linseed oil paint, and as it dries out in 8 to 10 hours, cars are painted and stenciled in one day, thus saving the labor of the second coat of linseed oil paint and the detention of the car till the next day to put it on. The Vandalia R. R. at Terre Haute are also testing this paint.

About three years ago the Standard Steel Platform for passenger cars, designed by H. H. Sessions, was placed upon the market by the Standard Coupler Company. It is now in use on eighty railroads, besides being the adopted standard of the Pullman Company. The President of the Standard Coupler Co., Geo. A. Post, makes the interesting statement that, during the first three months of 1900, shipments of steel platforms have been made for application to equipment of railroads that, in the aggregate, operate in every state and territory of the United States, except Delaware, and as well in Canada and Mexico.

The Ashcroft Manufacturing Co., 85 Liberty St., New York, have issued a new catalogue which they have endeavored to make complete in every detail in illustrating and describing their well-known products. The Ashcroft pressure gauges, Edson pressure recording and alarm gauge, the Ashcroft revolution counter, the Keyser automatic water gauge, the Moscrop speed recorder and the Tabor steam engine indicator are included, and it is evident from this catalogue that this firm aims to keep abreast of the times in meeting new demands for devices in these and similar lines. The book is bound in buckram and is well printed and clearly illustrated. It has an index.

Railway Motor Engineering is a new course of instruction offered by the International Correspondence Schools, Scranton, Pa. The course was prepared and is being kept up to date by Eugene C. Parham, Superintendent of the Nassau Division of the Brooklyn Rapid Transit. It is intended for operators and those who wish to become operators of electrical machinery and contains practical instruction on the operation and maintenance of electric cars and motors. As instruction is carried on by mail, it affords means for acquiring valuable information without obliging students to lose time from work. The International Correspondence Schools were established in 1891 and have nearly 100 courses and over 165,000 students and graduates.

An impressive demonstration of the effect of "Cling-Surface" in a recent emergency in an electric railway power house is described by the Editor of the Sibley College Journal of Engineering, Cornell University. He, with others, was making electrical tests under the direction of Professor Carpenter of Cornell at the power house of the Buffalo (New York) Street Railway. While the tests were progressing it was snowing, according to the account, at the rate of six inches an hour. An ice jam had formed in the Niagara River, and the power from Niagara Falls was shut off, compelling the railway company to do its storm work with power from their own engines alone. These were forced to the utmost. The belts strained and groaned, and ran with a great deal of slack in their non-driving sides. All the belts held except one. That one was dry and hard, with a shiny, glassy surface, while the others which did not slip had been treated with Cling-Surface.

The Chicago Pneumatic Tool Co., manufacturers of the Boyer and other pneumatic tools, have issued a unique pamphlet of 158 pages containing reproductions of testimonial letters from firms who are using these tools. Such an array of favorable testimonials has never before been brought to our attention. The appreciation of these tools, expressed in these letters, is convincing evidence of the high position they have taken because of their labor-saving possibilities. In some cases several letters from the same firm testify to continued use and satisfaction. The letters refer to different appliances and the high standing and prominence of the firms gives weight to their favorable opinions of which any manufacturers supplying them should be proud. This pamphlet contains nothing but these letters. It is a convincing argument in favor of the tools. They have brought about a revolution in methods of building and repairing boilers, ships, locomotives and work of similar character. Many of the letters mention this fact.

An exhibition was recently made at the Art Museum, in Springfield, Mass., of the results of work done by local students in the International Correspondence Schools of Scranton, Pa. This exhibition was of special interest as showing how far comparatively uneducated people may progress by improving spare moments in the study of lines of work in which they desire to perfect themselves. The Correspondence Schools interested in this exhibition have a remarkable following in that city, over 600 persons being enrolled there. The work covers almost every line in which working people are interested. An ambitious young man who has been forced to slight his common-school education turns to the courses offered by these schools, and, selecting the one in which he is most interested, begins the study. The plan of the courses pre-supposes only the ability to read and write. The first work is elementary and the progress is gradual and possible only by becoming perfect in what has preceded. The student goes through the course and at such a time as he completes the work receives a diploma, and the management of the schools is also interested in securing for the graduate better employment in keeping with his proficiency. The exhibition was made in Springfield at the suggestion of the City Library Association.